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BIRDS OF PARADISE.

BY T. W. WOOD, F.Z.S.

Those exquisitely beautiful creatures, the Birds of Paradise, have long attracted attention among the stuffed specimens in our museums, and now, through the energy and enthusiasm of Mr. Alfred R. Wallace, the public can make the acquaintance of one of the finest species in a living state. I am also personally indebted to that gentleman's kindness in allowing me to make copious use of his papers on the subject.

Describing more particularly the Great Bird of Paradise, *Paradisea apoda*, he tells us that no one can traverse the forests of Aru, without hearing "a loud, harsh, and oft-repeated cry, wawk, wawk, wok, wok, wok." This is the note of the Paradisea, constituting his morning and even song, and frequently sounded throughout the day. So far from being, as was once supposed, a very rare bird, Mr. Wallace assures us it is plentiful all over Aru, and is, in fact, a common species. It is, however, most frequently met with in a young and immature state, and our enterprizing traveller shot more than a dozen in that condition before he even saw a perfect male. It is in the loftier trees that the full grown males live, flying from branch to branch and from tree to tree in constant activity; but keeping a wary eye on all intruders, and being so tenacious of life as not to fall an easy prey before the naturalist's or the sportsman's gun. Before sunrise the Great Bird of Paradise is on the wing, seeking his food, but, unlike many other fruit-eaters, he is moderate in his appetite, and preserves his activity through the day, instead of following their example of gorging until repletion produces torpor, and compels repose. Such being the character of this interesting denizen of the dense and secluded forests, we look for a corresponding development in physical organization, and are not surprised to learn that—

"On examining a freshly killed bird, we see the great muscular strength of the legs and wings, and find the skin to be remarkably

thick and tough, and the skull, as well as the bones all very hard and strong. The whole neck is lined with a thick muscular fat, exactly similar to that of the Cephalopterus ornatus, in the same position, and probably serving in both cases to nourish the highly developed plumage of the adjacent parts. This causes the throat to appear externally very wide, and as if swollen, which displays to great advantage the dense, scaly, metallic plumage. The flesh, as might be expected, is dry, tasteless, and very tough—to be eaten only in necessity. By far the greater number of birds I have opened have had their stomachs full of fruit, and this seems to be their usual and favourite food. At times, however, they seek after insects, principally Orthoptera; and I have found one of the largest of the Phasmidæ almost entire in the stomach of a full plumaged bird."*

The natives of Aru only obtain these birds during the East monsoon, and hence invented theories of their migration which do not correspond with the fact. It is—

"About April, when the change from the west to the east monsoon occurs, the Paradiseas begin to show the ornamental side feathers, and in May and June they have mostly arrived at their full perfection. This is probably the season of pairing. They are in a state of excitement and incessant activity, and the males assemble together to exercise, dress, and display their magnificent plumage. For this purpose they prefer certain lofty, large leaved forest trees (which at this time have no fruit), and on these, early in the morning, from ten to twenty full-plumaged birds assemble, as the natives express it, 'to play and dance.' They open their wings, stretch out their necks, shake their bodies and keep the long golden plumes opened and vibrating—constantly changing their positions, flying across and across each other from branch to branch, and appearing proud of their activity and beauty. The long, downy, golden feathers are, however, displayed in a manner which has, I believe, been hitherto quite unknown, but in which alone the bird can be seen to full advantage, and claim our admiration as the most beautiful of all the beautiful winged forms which adorn the earth. Instead of hanging down on each side of the bird, and being almost confounded with the tail (as I believe always hitherto represented, and as they are, in fact, carried during repose and flight), they are erected *vertically*, over the back from under and behind the wing, and then opened and spread out in a fan-like mass, completely overshadowing the whole bird. The effect of this is inexpressibly beautiful. The long ungainly legs are no longer a deformity, as the bird crouches upon them, the dark brown body and wings form but a central support to the splendour above, from which more brilliant colours would distract our attention; while the pale yellow head, swelling throat of rich metallic green, and bright golden eye, give vivacity and life to the whole figure. Above, rise the intensely shining, orange-coloured plumes, richly marked with a stripe of

* *Annals of Natural History*, 1857.

deep red, and opening out with the most perfect regularity into broad, waving feathers of airy down; every filament which terminates them distinct, yet waving and curving and closing upon each other with the vibratory motion the bird gives them; while the two immensely long filaments of the tail hang in graceful curves below."

After mentioning the manner in which the natives procure this bird by building a small inartificial looking hut in the tree while the birds are absent, and shooting them with arrows when a sufficient number have arrived, by concealing themselves in the hut, Mr. Wallace continues:—

"Of the geographical distribution of the Bird of Paradise many erroneous statements have been published. Its supposed migration have by some been extended to Banda, by others to Ceram and all the eastern islands of the Molucca group. These statements are, however, totally without foundation, the species being strictly confined to the New Guinea and the Aru Islands, and even to a limited portion of each of those countries. Aru consists of a very large central island, and some hundreds of smaller ones scattered around it at various distances, many being of large size and covered with dense and lofty forests; yet on not one of these is the Paradisea ever found (although many of them are much nearer New Guinea), being limited to the large island, and even to the central portions of that island, never appearing on the sea coast, nor in the swampy forests which in many places reach some miles inward. With regard to its distribution in New Guinea, the Macassar traders assured me it was not found there at all; for, although they obtain quantities of 'Burong mati' (the Malay name), from most of the places they visit on the west coast of New Guinea, they are all of another kind, being the Paradisea papuana, a smaller and more delicate, but less brilliantly coloured species. On inquiry I found that they did not trade eastward of Cape Buro (135° E). Lesson, I believe, found the larger species in the southern peninsula of New Guinea, and an intelligent Ceramese trader I met at Aru assured me that, in places he had visited more eastward than the range of the Macassar traders, the same kind was found as at Aru. It is therefore clear that the Paradisea apoda is confined to the southern peninsula of New Guinea and the Aru islands, while the Paradisea papuana inhabits only the northern peninsula, with one or two of the islands (most probably) near its northern extremity."

The birds now living in perfect health at the Zoological Society's Gardens are two males of Paradisea papuana. Their habits in the aviary remind one very strongly of a jay or jackdaw, being very restless and prying in their disposition, often clinging to the perpendicular parts of their cage wherever there is a hold for their feet, and even hanging suspended under a branch like a titmouse. When on the ground, their mode of progression is by hopping; and their call consists of a

series of very loud but pleasingly varied notes. Not only are these notes varied in themselves, but they are also differently arranged at different times; the birds, however, possess two or three distinct series, which are more frequently repeated than the others. Mr. Wallace says that their note differs much from that of the wild birds, the latter terminating their series with a single low note, whereas the former often finish with a kind of gobble repeated twice. One of their notes uttered occasionally is exceedingly like the caw of a rook or jackdaw, but less harsh; another resembles the word "Jacob." These birds display their long plumes generally in the forenoon after a bath, and when their toilet is thoroughly completed; the body then assumes a position almost erect, the feet clinging to the perch very tightly, otherwise the bird would fall backwards; the wings are raised, fully extended and widely separated from the body; the bird is seen to shake the whole body, at the same time expanding the lovely ornamental feathers, the uppermost and shortest of which are elevated the most, their ends hanging over in a most graceful manner. At each side of the plume the brilliant, shining orange colour is seen extending to more than half its length, and gradually fading all round into the pure white in a most exquisite manner, a strip of the richest red-brown, almost black in its depth of colour, running through the orange colour to about one quarter the length of the plume—the wings have a slight flapping movement during this display, and the tail with its two long bare shafts are thrust forwards under the perch.

While the birds are thus showing themselves to the greatest advantage they suddenly commence jumping and turning themselves about on the perch in a very excited manner, uttering at the same moment a series of screams, louder and more piercing than any of their ordinary notes. The two birds are almost sure to "show off" both at the same time, and a careful observer may notice that the pupil of the eye is continually contracting and dilating. The bill is of a light greyish-blue colour, and has an opaque appearance; the iris is pale greenish-yellow; feet lead colour; of course none of these colours are seen in the preserved skin, but the colours of the feathers may be retained in all their intensity by excluding the light as much as possible.

As is well known, there are several other species belonging to this group of birds, almost each one possessing something quite unique in the manner of its ornamentation; the Semeioptera Wallacii, for instance (named after our intrepid traveller and discovered by him), possesses two long thin whitish feathers growing from amongst the lesser wing coverts; this gem was found in the Island of Batchian, one of the Moluccas, and the

natives spoke of another and finer black species with longer plumes, but Mr. Wallace, after many inquiries and much fruitless exertion, was obliged to leave without ever seeing a specimen.

The following is extracted from a paper recently read by Mr. Wallace at a meeting of the Zoological Society of London:

"Nature seems to have taken every precaution that these, her choicest treasures, may not lose value by being too easily obtained. First we find an open, harbourless, inhospitable coast, exposed to the full swell of the Pacific Ocean; next a rugged and mountainous country, covered with dense forests, offering, in its swamps, precipices, and serrated ridges, an almost impassable barrier to the central regions; and, lastly, a race of the most savage and ruthless character in the very lowest stage of civilization. In such a country and among such a people are found these wonderful productions of nature. In those trackless wilds do they display that exquisite beauty and that marvellous development of plumage, calculated to excite admiration and astonishment among the most civilized and most intellectual races of man. A feather is itself a wonderful and beautiful thing. A bird clothed with feathers is almost necessarily a beautiful creature. How much then must we wonder at and admire the modification of simple feathers into the rigid, polished, wavy ribbands which adorn P. Rubra, the mass of airy plumes in P. apoda, the tufts and wires of Seleucides alba, or the golden buds borne upon airy stems that spring from the tail of Cicinnurus regia, while gems and polished metals can alone compare with the tints that adorn the breast of P. sexsetacea and Astrapia nigra and the immensely developed shoulder plumes of Epimachus magnus."

A DREDGING EXCURSION.

BY D. WALKER, M.D., F.L.S., CORR. MEM. Z.S., ETC.

LIVING on a sandy seaboard where there are few rocks and little shingle, I have often been disappointed in my search along the shore for specimens of marine natural history. Many fruitless hours have been spent with such meagre results, that I have frequently returned home murmuring at the circumstances which placed me in a locality so destitute of a luxurious marine fauna. My opportunities for dredging are few and scattered; all however are eagerly taken advantage of, and with a hope that some readers similarly situated may follow my example, and receive some pleasure from the perusal of a few reminiscences of my last dredging excursion, I jot them down, adding, as they occur to me, such practical hints and details—needful, but not dry—as may enable others most advantageously to pursue this healthful and fascinating study.

With most shore-dredgers and amateurs, the greatest depth at which they can dredge with ease will be about ten or fifteen fathoms, so that any observations that I may make must be understood as referring to such an expedition. One preliminary remark as to companions: as a rule, not more than two or three should form the party, exclusive of the boatmen; and it would be as well, perhaps, if you go on a rough day, that none were subject to sea-sickness, which would certainly mar your pleasure, if it did not take away your profit. A fine day should, if possible, be chosen, with a clear sky and a good breeze. Then time your starting so as to go three hours before low water, and return with the flood, eight or nine hours being sufficient for the most ardent zoologist on this coast. Our destination is the north-west lightship, off the mouth of the estuary of the Dee; so having secured a good boat, efficient boatmen, and everything necessary for our purpose, we will start if you please from New Brighton pier, and get as soon as possible into the Channel, hauling our wind as needful, and keeping near the buoys unless we wish to run ignominiously aground on a sandbank. With a good wind we shall generally reach the dredging ground at low water, passing on our way flocks of ducks and plenty of gulls, at which the sportsman may try his hand if he please.

If the wind be not too high, or the swell too great, we may have put out a towing-net—a bag made of bunting or canvas, eight to ten inches wide, and twelve to fourteen inches deep, attached to an iron ring, and towed astern by means of a line fastened to a triplet cord. This net skims the surface of the sea, frequently catching beautiful specimens of Acalephs. They will seem to the uninitiated hardly worthy of notice, appearing as they do like lumps of almost transparent jelly lying in the corners of the net; but in their own element they will amply repay observation and attention. If these be placed at once in a glass jar of water, by inserting the bag into the jar the movements of the *ciliæ* will be beautifully seen. They are not likely to injure the hands of those who touch them, having this advantage over their foreign relatives, which have more than once given me a rather severe attack of *whitlow*. As you closely look at these gelatinous creatures you will notice that they may be divided into two sets; one set, *Cydippe*, have long thread-like appendages, which are absent in the others. These (*Beröe*) are oval and hollow, furnished with eight longitudinal radii, which pass from the small end to near the margin of the large extremity. These lines have each a *single* series of short ciliæ or hair-like appendages, which move with great celerity and gracefulness in a wave passing from the top to the margin. The iridescence and play of colours displayed when these

beautiful creatures move through the water is beyond the imagination of those who have never witnessed it. In the Polar Seas I have seen the surface of the ocean covered with quantities of the *Beröe ovata*, and other Acalephs, which form a principal part of the food of the whale. The specimens of *Cydippe pileus* which we have obtained are not so large as the *Beröe*. They are somewhat globular, and have, besides the long thread-like organs, a *double* series of ciliæ attached to each of the eight longitudinal radii. The long threads you will find are moveable according to the will of the animal, and are retractile, and are also furnished with ciliæ. The average size of the *Cydippe* is about five lines and a half by four lines.

We are now on the scene of our operations, and the helm is put up, bringing the boat to the wind. As she drifts, the dredge is brought to the stern and let go to windward. Twice the quantity of line required by the depth of water is payed out, made fast to a belaying-pin, and the remainder coiled up in the bottom of the boat, the end being fastened to the mast for safety. While we discuss the provisions which provident dredgers supply, and which you will by this time feel the need of, three hours being supposed to have elapsed since leaving the shore—I will give you an idea of what operations are going on at the bottom of the sea. And first to describe the dredge in its simplest form, as others, however needful on stony bouldery shores, would be quite out of place here. Our dredge, then, consists of a framework of iron and a net or bag. The frame is made with moveable joints, to fold and carry in the hand, and is from eighteen to twenty inches long, and from seven to ten wide. The edges of the two long pieces are made broad for scraping; the cross pieces are merely for the handles of the dredge, and have two swivel joints, so that a sideway motion as well as the ordinary forward and backward one, is obtained, which is useful in case of the dredge fouling stones, etc. The two handles end in two rings, through which the dredging-rope is passed and made fast. Care should be taken that the knots are not made in what sailors call "a lubberly manner," or it is very likely that they may slip, and the dredge be left at the bottom of the sea, to be triumphed over by the inhabitants as one of "our failures." The bag of our dredge is made of tolerably thick line, woven into a net, the meshes not very large, and it is fastened to holes in the scraping side of the framework. The dredging-rope should be sufficiently strong to anchor the boat in smooth water; though, of course, if there be much way on her, that could not be expected. This strength is requisite in case of the dredge fouling, when it is needful to let out some of the spare line and relieve the strain while the boat is being brought round. The dredge then capsizes, and can be hauled up.

A good deal of judgment is required for the regulation of the line: if too long, the dredge will be in danger of getting fast; if too short, it will only skim the bottom. If the bottom be sandy or muddy, the boat must have pretty good way on her or the dredge will bury itself. If rocky, or composed of boulders, shorten the line, or the strain will break it: but experience is the only teacher; and the feel of the line soon tells whether the dredge be properly bumping or scraping the bottom. Before lowering the dredge a weight is to be fastened on the line, a fathom or two from the handles, in order to keep the strain as near as possible on the plane of the bottom.

Sweeping thus along, whatever comes in the way of the dredge is draughted into it, the water escaping through the meshes, and leaving the live desiderata and dead shells in the inside. It is often advisable, especially in dredging over hard and pebbly ground, to have a lining-net inside the dredge-net. This should be made of bunting, and will often secure rare shells, such as *Mangelia, Scalaria,* etc., which would otherwise have escaped with the rush of water. When a sufficient distance has been traversed, or the straining of the rope seems to render it desirable, the boat is brought to, the dredge and its contents hauled on board and capsized into a sieve of quarter of an inch mesh, or, as we are amateurs, a basket, which will answer our purpose just as well.

And now begins our real work. "What," cries Mr. Delicate Faintheart, "do you call it delightful and fascinating to poke about in that dirty black mass of mud and stones? If that be the only way to secure specimens for aquarium or microscope, I beg to decline having anything to do with either," and our fastidious friend returns to his sandwiches: we laugh at him, and set to work all the more vigorously. In the basket we find a portentous mass of dirt, stones, crabs, sea-urchins, oyster shells, etc.; at once we pounce on them, and our one companion becomes quite excited as he fumbles among the mud, having come across a crab, and finding, when he has worked the mud off his shell covering, that he has discovered the rarer species of *Hyas. Hyas coarctatus,* or the contracted spider crab, his carapace, or shell, is in form somewhat between a fiddle and a lyre; the first pair of legs half as long again as the body. He is the largest yet met with there, his carapace measuring 1·7 inches by 1·1 inches. Put him into water and you will see that those dirty-looking things upon the back are beautiful zoophytes. I have met with this species in Greenland. Crawling over the surface of the stones and mud, I see a long-legged spider crab, with a very small back; no other *Stenorynchus* having been found here, you may be pretty sure he is *S. phalangium;* the second pair of legs in this crab are almost four times the length of the body,

all the legs and the back are covered with hairs, and frequently pieces of seaweed and small sponges; it moves very sluggishly, and dies in a very short time if kept out of water. Presently my friend catches hold of a ray protruding from the mud, and dexterously disentangling it, it proves to be *Ophiocoma rosula*, the common brittle star; the five comparted disk is covered with spines, and in this case is white, spotted with red, the rays are banded with amber, while one is of a dark blue with roseate spines. Take care how you touch him, for if you handle him much he will, in the most spiteful manner, break off his rays and throw them at you in disgust. These are very common, their arms appearing at almost every one of the meshes of the dredge. Now, however, the motion of the boat begins to tell us that we have got into a chopping sea, and, turning towards my dainty friend of the sandwiches, we see that he has resigned himself to his fate. Considerably sobered by this affecting sight, my remaining companion resumes his search in the basket, but finding that a stooping posture is not agreeable in the seaway, he most reluctantly joins his companion in tribulation.

Not being particularly susceptible to these weaknesses, I call the boatman to my aid, and pick away alone in my glory. On yielding to the enemy, my friend has dropped his last prize, a beautiful *Pecten opercularis*, well worth preserving; for beside the pleasure of seeing the valves open and display the gem-like eyes which fringe the mantle, the surface of the shell is covered with corallines of exquisite delicacy—*Plumularia*, *Sertularia*, and other equally interesting organisms. Another dead valve has a little group of the angular stems of the *Laomedea geniculata*, with their red, jelly-like extremities, which, when placed in water, expand and show themselves to be campanulate alternate glassy celled polypes, with many tentacles attached to each. Ha! there is a crab trying to walk up the side of the basket and get away, take care of him, he is new to this district —that is a *Portunus marmoreus*, or marbled swimming crab. See his hind legs, how they terminate in broad, swimming plates, finely ciliated, enabling this cleanser to scuttle about in a very active manner; his back is marbled with the most beautiful varied patterns, the arched lines on the carapace are covered with deep blue points, while each region into which it is divided has apparently its own shade of brown, buff, and red. If the foreclaws be examined with a lens, the exquisite sculpture will be seen, the four keels notched and toothed with fine indentations, and the one sharp tooth at the inner angle of the wrist; his brethren, *P. puber* and *P. depurator*, are now scarcely so common on this coast, having been partially replaced by a colony of *Portumus marmoreus*. Here is another crab, with brownish-green legs, dull red abdomen, and dark green back; a sulky-

looking fellow, who tries to escape by awkwardly shambling, as if he wanted to skulk away and watch you at the same time; that first pair of legs is armed with remarkably strong thumbs and fingers, as you will find to your cost if you come within range of their operations, that is *Carcinus mœnas*.

Now my friend has recovered from his sickness, and by no means disheartened, returns to the grubbing, evoking from the mud a beautiful urchin, all covered with spines; it proves to be the *Echinus Flemingii*, a rare species, and not the common sea-urchin, as at first we supposed. Another dive into the basket brings out a single ray, what is it? Part of a sand star; and on looking closely we find a disk with four rays, to which the former one evidently once belonged, but he has parted with it under the pressure of circumstances, as he was jammed in between two stones, from which perilous position you have just rescued him and prevented further mutilation. Examine him with your pocket lens, and you will see thirty or forty imbricated plates covering the rays; examine also the small spines on their sides, and count the teeth in the frill, at the base of each ray, where it comes off from the disk. Another star also emerges from the basket, a much smaller species; these two are *Ophiolepis texturata* and *O. albida*. But the boatman has also been at work putting everything alive into the glass jar beside him, and all at once we hear a knock, knock, tap, tap, against the side of the jar. Looking in we see a large *Buccinum* moving most mysteriously over everything, so we turn the shell round and find that it is tenanted by a Hermit crab. *Pagurus Bernhardus* has made it her home, and is now inspecting the new locality in which she finds herself, her long claws go clacking against and over all impediments, the shell bobbing along after. Look how she works those organs attached to her head, feeling here, and listening there, as she stands still and gazes out with those large goggle eyes. Give this crab a piece of mussel and watch those internal and smaller antennæ how they move whilst feeding; the jaw-feet, or pedipalps, shovelling the food up, creating a constant current towards the mouth, and making the water turbid with the sand attached to the mussel shell. Having disposed of that dainty, a change of residence is deemed advisable. See how cautiously she feels over that empty shell with her long claws, the eyes staring intensely the whole time, till satisfied with the proposed new tenement, the body is carefully drawn out of the old shell, and with great dexterity whisked into the new one, as if she were afraid that some one would attack her from behind at this advantageous moment. Another plunge brings up a twelve-rayed sun star, with his rich scarlet disk, the rays white and tipped with red near the extremity; put a small specimen into, and watch how

soon it fastens itself to, the jar, and begins to crawl with the thousand suckers it protrudes from rays and disk—this is *Solaster papposa*.

Here is a *Trochus*, or "top," with his roughly granulated whorls beautifully marked and sculptured, its pointed spire and finely turned lip. There are one or two rarer *Mangelia* and a *Triton* crawling along the bottom of the basket. But see, the boatman is just throwing a handful of mussels overboard, and when we stop him, he abandons his occupation in contempt at the idea of our being such fools as to come this distance to pick mussels. Well, "all is not gold that glitters," and *vice versâ*. Turning to the despised mussels, we find something sticking to the shells, and, as we touch it with the nail, we perceive that we have some nice specimens of *Flustra* with parasitic *Cellularia*, and other interesting varieties of the Polyzoa. Now look attentively at that stone, see those two slugs—one dirty grey and one with red tipped tentacles; these are both specimens of Nudibranchs. Put them into the jar, you will see the former expand its beautiful barred or ringed gills, and close to the eye you will see two beautiful toothed horns, that is a *Doris;* the other is much rarer *Eolis rufabranchialis;* we shall soon most likely encounter a white *Eolis*. Here is another bunch of mussels, each fastened by his thread-like byssus to a small stone, and all tied together, sociably enjoying each others' society. Crack one with a hammer, and lo! a very tiny Pea crab (rejoicing, like other little people, in a long and important name, *Pinnotheres pisum*) looks out of his shell; he is beautifully blotched with brown patches on a yellow or orange ground. The old superstition was, that Nature had not given the mussel eyes, so he made a compact with our little friend similar to that which the blind man is said to have made with the lame, according to our schoolboy tradition.

While we have been sorting this basket, the boatmen have had their shank-trawl overboard, which is a net twelve feet by ten, fastened to two "trawl heads" as they are called, which I may explain, for the information of the uninitiated, to be semicircular flat bands of iron attached to the extremities of a wooden beam, which extends for the whole length of the net, the lower mouth of which is weighted by a chain wolded round with old rope. As the net sweeps along the bottom, the upper mouth kept open by the trawl heads and beam, the fish, rudely roused from their repose by the chain, rush into it as their nearest place of safety, and suffer the consequences of their rashness. All hands are called to haul the net on deck; quantities of plaice, *Platessa vulgaris*, and soles, *Solea vulgaris*, are floundering about, but look! what a beautiful fish we have here, the Gemmeous Dragonet, *Callionymus lyra;* admire its different

shades of yellow, and the sapphirine stripes which cover its body and head; look at the black tail-fin, and the finely arched first ray of the fin on its back. Here is the spotted Goby, *Gobius minutus*, if you turn him over you will see under his throat the disk by which he can attach himself to rocks and stones; put him anywhere, he will live a long time out of water. Here is the "stingfish,"—get him over the side as soon possible, touch him not, or you will find some of the poison oozing out from each of his hairy hollow spines transferred into your blood. There is a fine specimen of the male "masked crab," *Corystes Cassivellaunus;* look at those long graceful arms, and observe the mask on his carapace when you have washed him; watch how he twirls and brushes those elegant antennæ, just as a modern dandy does his moustache.

There, hopping about in a very lively style, are some long, transparent, shrimp-like animals, their bodies beautifully banded with dotted rings of golden amber, and each leg at the joints similarly ornamented; how their antennæ move about as they are put into the water; those triplet antennæ with brown bases, the ends like a whip, these are *Squillæ*. Close to them are numbers of *Crangons*, "common shrimp," and *Pandalus*, or "Esop prawns;" how unlike those yellow and red animals which are such agreeable adjuncts to our tea-table; admire the notched keel of those "Esops," and their upturned points; you had better put them by themselves, else they will be eaten up by so many crabs. Here, hidden under a stone, is a specimen of the "spotted gunnell," with a long, ribbon-like body, which writhes away under the stones, it is spotted along its upper side with brown dots, the dorsal fin extending almost the whole length of the body, the anal for two-thirds. That broad, ungainly-looking crab, stalking about on those shells, is the "angular crab," *Gonoplax angulatas;* his eyes are set, as you see, on remarkably long stalks, and mark the groove along which they lie when not in use; what an awkward companion he must be with those enormously long arms! Here are quantities of the common "cross fish," *Uraster rubens;* turn them over before you throw them away, you may find some interesting bivalves sticking in their suckers. See there is one with a fine glassy, almost transparent shell, *Syndosmya alba;* it is worth looking at at home: there is also a specimen of that apparently shelless mollusc, *Philline aperta*, a fine specimen for dissection. But here is something we have not seen before: into the jar with him at once, and watch him; the head seems as large as the body, with large staring eyes at the side, the neck considerably contracted, the body with two wing-like appendages which wave through the water, enabling the little creature to swim; out of its head grow ten arms, eight of which

have small cups or suckers on the inner side, and two larger ones which only have cups at their extremities, how delicately the whole body is painted over with spots; touch him, and at once the clear water becomes black with the cuttle-fish ink, for that is the *Sepiola atlantica.*

Pick up that mouse-like animal—its back is covered with a kind of down, out of which sprout spines of different length, coloured with all the hues of the rainbow, the score or so of bristles exhibiting every imaginable brilliant metallic tint. When you go home put one of those hairs under a microscope, and see how nature has provided a hard sheath into which these weapons are retracted, so that the soft parts of the animal can receive no injury; pluck some of the down off the back, and you will expose a double set of large scales attached to the alternate segments of the animal; that is the hairy sea-mouse, *Aphrodite hispida.* Here is another Annelid, a *Nereis,* which boasts of a distinct head, eyes, and mouth, and wriggles about by means of the tentacles issuing from its many feet. Look at this dirty, leathery tube fastening to a large stone, place it in the water, and in about five or ten minutes, if you look again, you will see such a rainbow frill, such a circle of plumes surrounding the opening! that is a *Sabella,* and those are its branchiæ or breathing organs; that central elongated disk acts as an operculum, and although funnel-shaped is not pervious, but is one of the tentacles purposely enlarged to plug up the aperture of the tube when the animal retreats within. To the same stone adheres very tenaciously a small shell, which on a close examination you will find to consist of eight plates, overlapping each other at their edge and joined together by a leathery mantle; get it off the stone with your nail, and, holding it in your hand for a minute, you will see the plates separate, and the extremities come close together, till what was a flat surface has become almost a ball; in the jar, however, it soon fastens itself to the side, where you may see the muscular foot, the expansion and contraction of which form the locomotive power of the animal, that is a *Chiton, Ch. cinereus,* admirable for the beautiful moulding on his back. Here is a white *Eolis,* with gills arranged on each side, the tentacles not retractile. There is a good sized globular shell with four or five whorls, nicely dotted with brown streaks on a greyish-yellow ground; drop him into the jar that you may view the large foot with a large, broad lobe in front, so broad, indeed, as to conceal the head, close to the lobe you will perceive the tentacles sprouting out, this is a carnivorous mollusc, *Natica monilifera.* In the bottom of the basket you may find what is called "an elephant's tooth," *Dentalium entalis;* notice the shell, it is tubular, slightly curved and tapering from end to end, with an opening

at each extremity, one very small; the other, through which it is intended the animal's body should protrude, is proportionately larger; the head in the middle of the body is surrounded by gills; this mollusc is a sand-borer, and feeds on minute marine animals. Almost hidden from our view is a small crustacean belonging to the sessile-eyed division of the family; watch how it scuttles along on its side when it reaches its native element, using its swimming feet so constantly and so rapidly, as to suggest the idea of their being worked by a small private steam-engine; if you examine the antennæ of this creature, you will see two small secondary feelers sprouting from the upper pair, the lower pair having no such appendages; glance at that broad hand, with its finger so admirably adapted for nipping, and view the structure of the swimming plates and tail so delicately fringed with ciliæ, that is a *Gammarus, G. sabini.* Near him lies *Galathea squamifera*, a stalk-eyed crustacean, with pointed notched rostrum, and long fore feet, its abdomen and swimming tail, neatly tucked away out of sight, completely concealing from our view the spawn which would soon form *Zoeæ*, and ultimately crabs.

And now, our jars being tolerably well filled, we turn homewards, rather tired, we must confess, but anticipating with no little eagerness the work that remains for us on our arrival there. Many a day may be pleasantly and usefully employed in examining, classifying, and identifying our specimens, and dissecting those whose organizations we desire to study more carefully.

THE SUNFISH AS A HOST.

BY T. SPENCER COBBOLD, M.D., F.L.S.

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Some credit is due to those of our continental brethren who have devised a set of simple terms calculated to express the relations subsisting between different forms of animal life, both as regards the species themselves and the various phases of being known to occur in one and the same individual. The Danish naturalist Steenstrup first suggested the convenient titles of "nurse," "grandnurse," and so forth, in reference to "parents" producing non-sexual broods of larval flukes by the now well understood process of internal budding; and, in like manner, Von Siebold, and other German parasitologists, fittingly applied the term "host" to any animal actually infested with, or liable to be attacked by parasites, because it thus, as it were, entertains within its own body the presence of

these singular creatures. In their view, the question as to whether the company of entozoa be acceptable or not to the "host" in no way prevents the invaders being recognized as guests, whilst in most cases they are sumptuously entertained, although they be not welcome. The organization of the entozoa admirably adapts them for a temporary residence within the body of the selected "host;" so much so, indeed, that from their peculiar organization, one might fairly argue their legitimate title to such an abode; yet, at the same time, it must be admitted that the means of entry at their command, as well as the instincts they exhibit in their mode of gaining access, do but epitomize the instincts of the genuine burglar. In few cases, if in any, can it be shown that the presence of animal parasites confers positive good to the "host;" but in numerous instances it is certain that they cause incalculable mischief. This was sufficiently shown in our paper on *Fasciola hepatica*, in the first volume of the INTELLECTUAL OBSERVER, and the subject has since been further elucidated by Professor James Beart Simonds, in his instructive memoir on the *Nature, Cause, Treatment, and Prevention of the Rot in Sheep.*

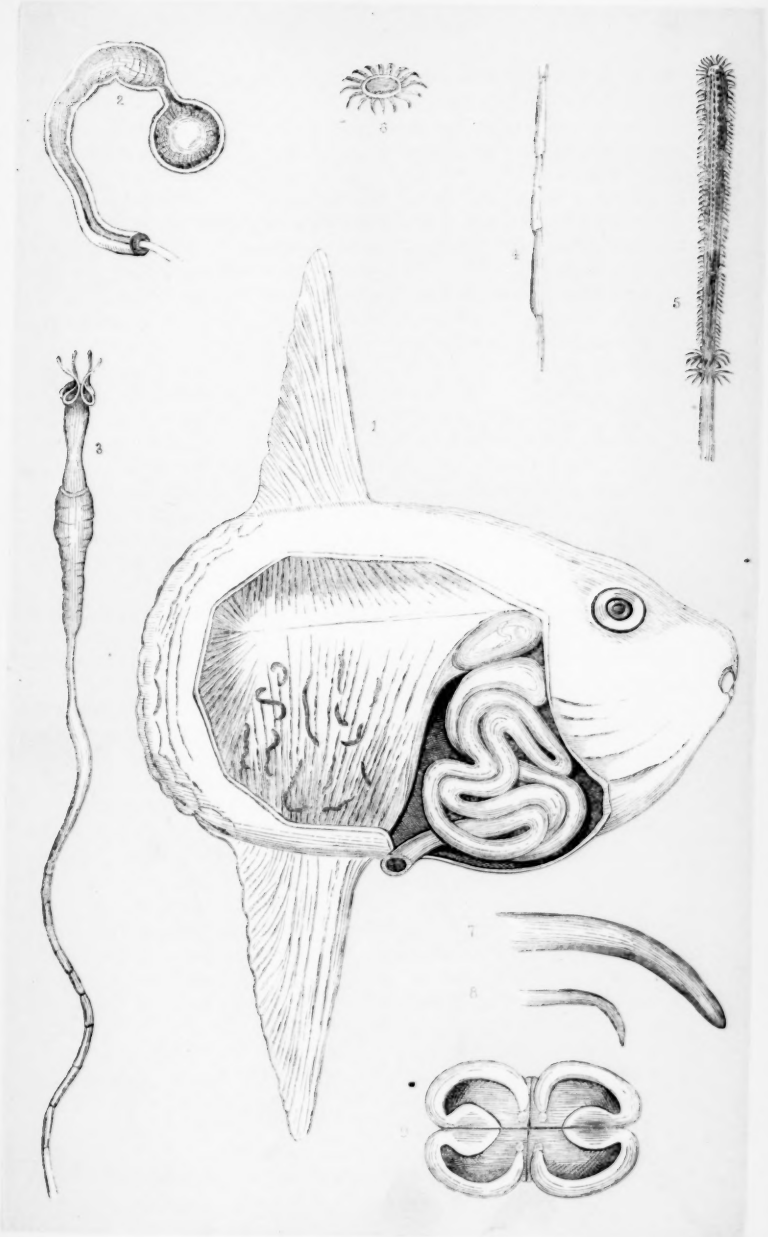
If the mere variety of parasites formed an accurate criterion of the hospitality, so to speak, of any given "host," the species here selected for the purpose of illustration might certainly be regarded as a very liberal individual; but it often happens that an animal liable to harbour only one or two forms of entozoa is more copiously infested by those few particular kinds than another animal which is liable to be infested by a much greater variety of parasitic guests. The short sunfish (*Orthagoriscus mola* of Schneider, and *Tetradon mola* of Linnæus) is believed to be infested by nine species of helminths, three of which are usually attached to the gills, while a fourth adheres to the surface of the body. All of the latter, though ecto-parasitic in their habits, are true flukes belonging to the genera Distoma and Tristoma, and cannot therefore be removed from the entozoa properly so called. In the present communication we propose to treat only of one of the above-mentioned "guests," selecting for this purpose a species which belongs to the great tapeworm family. We are aware that to some persons the study of this group of animals appears to be peculiarly uninviting; but in our own experience, based upon a prolonged contemplation of their structure, habits, and development, we can testify to the rare instruction and pleasure which such a research is calculated to afford.

Notwithstanding the light which experimental investigation has lately thrown upon the subject, the tapeworms are still regarded by many as individual animals, possessed of long jointed bodies, whereas the organism usually called a tapeworm—like

that, for example, shown at fig. 3 in the accompanying tinted plate—is not one individual animal, but in reality a series of individuals associated together so as to form a long band resembling an ordinary measuring tape, the likeness to the latter gaining strength by the circumstance of the band being jointed, or transversely marked at tolerably regular intervals. Every tapeworm is, in point of fact, a colony of creatures arranged in single file, and in the more technical nomenclature of helminthology is termed the "strobila." As we have recently taken occasion to remark elsewhere, the tapeworm, or "strobila," is usually composed of several hundred joints, each segment representing a single member of the colony, and to this latter we apply the term "proglottis." Those individual "proglottides" which are nearest to the lower end, or so called tail of the ordinary tapeworm, are sexually mature; moreover, they are hermaphroditic, that is, they are provided with both male and female reproductive organs. Those feebly developed joints, which form the so-called neck of the worm, are imperfect or immature individuals, whilst the little head is neither more nor less than a single joint or proglottis, curiously modified and furnished with an apparatus by which the strobila or colony is securely anchored to the interior of the infested "host."

It is necessary that the above-mentioned facts be borne in mind, otherwise the true relation of the parts of the strobila or tapeworm to be presently described will be entirely lost sight of; and it becomes the more necessary to insist on these distinctions in cases where, as in the present, the application of our zoological nomenclature seems to lend countenance to the popular and erroneous notion that the strobila is, after all, only one zoological individual. So far as tapeworms are concerned our specific distinctions for the most part depend upon the characters presented by the so-called head of the worm; but this head is, as we have seen, the primary individual of the colony. It might be supposed that although the head of one kind of tapeworm-colony differed from that of another kind, yet the joints or members of the colony might display similar characters in different strobila, and so be after all the same creatures, although their so-called heads were different. Such a notion, however—which at one time was practically supported by Von Siebold himself when he denied the hitherto recognized specific distinctions of five well marked tapeworms (*Band und Blasenwürmer*, p. 98 *et seq.*)—is contra-indicated by numerous facts; for even the joints themselves exhibit co-ordinating structures, which are found to be invariable in the different tapeworm colonies.

The more complex the characters of any particular class of animals, the greater the confusion introduced into the writings



T. S. C., del.

Tetrarhynchus reptans.

of those who in earlier times directed their attention to the group. A glance at the literature of tapeworms renders this truth especially significant. Some investigators, indeed, spare themselves a vast deal of trouble by altogether ignoring the labours of previous writers; but deprecating this mode of procedure, we have always considered it due to antecedent observers to express some recognition of their researches, even in those instances where recent discovery has demonstrated the fallacy of their facts and theories. In this view, therefore, we offer a synonomy of the tapeworm, or strobila under consideration, which we take to be as follows :—

Gymnorhynchus reptans, Rudolphi, Bremser, Blainville, Nordmann, Dujardin.

Gymnorhynchus horridus, John Goodsir.

Acanthorhynchus reptans, Diesing.

Bothryorhynchus continuus, Van Lidth de Jeude.

Bothryocephalus patulus, Leuckart.

Anthocephalus elongatus, Rudolphi, Nitzsch, Nordmann, Drummond, Dujardin.

Anthocephalus macrourus, Bremser.

Floriceps saccatus, Cuvier.

Floriceps elongatus, Blainville.

Scolex gigas, Cuvier.

Here it will be seen that we have the same tapeworm described by twelve authors under ten different titles, whilst not less than seven of these authorities have considered the animal as referable to two separate species; moreover, as if to render "confusion worse confounded," several of them have adorned their descriptions with extremely inaccurate figures. Systematists and others who have not been fortunate enough to examine the species for themselves have naturally placed great store by the various representations given by Cuvier, Rudolphi, Bremser, Leuckart, and others; and thus the figure of one author is taken to represent a different species from that given by another, and a new name has been applied accordingly. Had the distinguished Professor J. P. Van Beneden, of the Catholic University of Louvain, chanced to have stumbled on this species, his skilful pencil would not have failed to have added another exact picture to the beautiful series of figures which illustrate his *Recherches sur la faune littorale de Belgique,* and he would thus have dissipated many doubts as to the identity of the species. For our own part, we have not hesitated to expose the accumulated errors which have crept into helminthological literature; and while offering an accurate illustration drawn to nature, we at the same time take leave to observe that this tapeworm should both in the first and last instances have been described under the appropriate

genus Tetrarhynchus, established by Rudolphi at a very early date. At the risk, therefore, of appearing inconsistent, we believe it to be in the interest of science to place the worm under this genus, whilst we retain the specific title "reptans" as fitly expressing its groping habits.

If attention be now directed to the accompanying plate, a correct understanding of the organization of this remarkable Cestode will be greatly facilitated. Fig. 1 represents a very juvenile example of Orthagoriscus, which was taken by fishermen off Anstruther, on the Fifeshire coast, on the 6th of September, 1856. Several full-grown individuals had been captured in the same neighbourhood some weeks previous, one very large example being subsequently anatomized by the professor of anatomy at the Edinburgh University. The small fish here drawn gave the following dimensions: length from snout to tail, eighteen inches; between tips of dorsal and anal fins, twenty-six inches; greatest depth of the body, twelve inches; length of pectoral fins, two inches and a half; width of gill aperture, one inch; consequently it will be perceived that our illustration represents the animal reduced to about one-sixth the natural size. Having placed our fish on its left side, a considerable portion of the integument was removed so as to expose the great lateral muscular mass of the right side, and more particularly also the abdominal viscera which are here retained *in situ*. At the upper border of the ventral cavity the liver is shown resting, as it were, upon the stomach, the latter being insensibly continued into the uniformly thick intestine; and the gut, after making five or six distinct sigmoidal flexures, terminates in front of the anal fin by a patent orifice. The surface of the liver was scarred by numerous worm-tracks, a few of the Entozoa still remaining within its substance, while larger and more vigorous specimens were groping their way among the lateral muscles, each worm being surrounded by a smooth and stoutish capsule. Portions only of these investing sheaths are seen in the accompanying drawing, it having been impossible, in the dissection, to expose any one of the parasites in its entirety. Several of them were afterwards dissected out and dropt into a tumbler of sea water, when, to our astonishment —for the fish had been dead about a week, and had been cast aside as refuse by the salesman of whom it was purchased— they moved about actively. On being further deprived of their investing capsules, the proboscidiform tentacula attached to the so-called head, were protruded and retracted in an irregular alternating manner. These movements continued until the third day following, when, muscular irritability having well nigh ceased, they were plunged into alcohol for future use and preservation. Some of the worms removed were from fifteen

to twenty inches in length, but they were imperfect individuals. On a previous occasion, from the liver of a full-grown Orthagoriscus—for the opportunity of examining which we were indebted to Professor Goodsir—we obtained several examples fully double this length. Even these were incomplete specimens; and it is impossible to calculate accurately the length any given worm may attain, because they are usually rolled together in inextricable confusion; moreover, the sheaths are much longer than the worms themselves, being, as it were, left behind in the tissues of the "host" wherever the parasites may have wandered. There are thus found permanent indications of the erratic movements of the "guests," and were it possible in an adult sunfish to unravel the entire sheath of a single *Tetrarhynchus reptans*, we should probably find the capsule—representing, be it remembered, the entire life-wanderings of the tapeworm thus far—at least one hundred feet long. In this case, of course, we assume the worm to have entered the fish while the latter was quite young. Whatever reflections such phenomena are calculated to excite, one certainly sees no reason to envy the piscine "host" thus destined to have its muscles and viscera tunnelled in all directions by an uninvited Tetrarhynch.

Several questions here naturally suggest themselves, such as:—What is the object of this perpetual tunnelling? Does the boring really cause suffering to the host? Do the parasites ever make their escape from the body of the fish? To some of these queries we believe ourselves capable of giving a satisfactory answer; but before doing so, it is necessary that we should complete our account of the organization of this worm. In this view, therefore, we have to remark that fig. 2 is a slightly enlarged, but otherwise exact, copy of the upper end of the Tetrarhynchus enclosed within its transparent capsule. The rounded extremity is not merely the so-called head, but it embraces also the neck and its subcervical enlargement—all these three distinct parts being represented in their unfolded condition in fig. 3. In the latter drawing, the numeral is placed opposite the constricted portion of the hour-glass-shaped neck. Immediately below this enlargement is a still more attenuated portion corresponding with the narrow neck-like constriction shown in fig. 2. The swellings below this, again, are identical in the two figures, but in the lower illustration the body of the worm is more drawn out. The so-called head in fig. 3 displays four proboscidiform tentacula—hence the generic title employed—and also four cephalic lobes, each of which is furnished with a sucking disk. In fig. 9, at the bottom of the plate, we have given an enlarged view of this so-called head, seen from above. The four proboscides are retracted within

sheathing-tubes, the orifices of the latter being closed by four papillæform elevations, symmetrically disposed near the centre. It will also be further seen that the sucking disks coalesce on either side, so that the four cephalic lobes are rather to be regarded as two auriculate appendages, deeply cleft transversely in the middle line. In form they strangely resemble, as it were, a pair of cloven hoofs placed heel to heel. The four proboscides are club-shaped, each being furnished with a complicated armature of hooks, arranged in circular rows. The latter, though scarcely visible to the naked eye, present a formidable appearance when magnified. This is shown in fig. 5, where one of them is enlarged twenty diameters. Very difficult was it found to ascertain the precise number of hooks, but after careful and oft-repeated examinations, we satisfied ourselves that each circle consisted of sixteen hooks (fig. 6), whilst there appeared to be fully one hundred of these rows on each proboscis. Each tentaculum, therefore, was calculated to carry about 1600 hooks, which would give us altogether a total of more than 6000 of these little instruments on a single tapeworm. The majority of the hooks displayed a tolerably uniform length and thickness when compared with each other, but the two lowermost circles near the base of each proboscis were two or three times the size of any of the others. Fig. 7 represents one of the large hooks, with its somewhat blunted extremity directed obliquely downwards; and fig. 8 shows one of the numerous small hooks having the end more curved, pointed, and retroverted. Both these figures are from hooks magnified about 250 diameters. The body of the Tetrarhynchus is distinctly segmented; the joints gradually acquiring greater conspicuity the further we recede from the so-called head. This character is partly exhibited in the lower half of fig. 3, but a few well-marked articulations from the posterior region of the body are faithfully illustrated at fig. 4. Lastly, it is particularly worthy of remark, that none of the segments display the slightest indication of the presence of reproductive organs, such as we should undoubtedly have discovered if the tapeworm or its joints had been fully developed and matured. The explanation of this will appear in the sequel.

Reverting to the questions previously mooted, we may observe, that the object of the tunnelling process appears to be two-fold: first, in order that the animal may constantly obtain fresh nutriment, and secondly, because the creature is impelled by instinct to seek out another "residence," which it can only gain by being transferred to a separate "host." The tapeworm not being supplied with any mouth or digestive organs, acquires nutriment by imbibition through the general surface of the body; and the reason why it needs transference to another

"host," arises out of the circumstance that the joints cannot become mature until the parasite finds its way into the alimentary canal of the "host" it is ultimately destined to occupy. It is a curious example of an animal perpetually striving to perform an act which cannot be accomplished by its own unaided powers, for our Tetrarhynchus must wait until a shark or other large fish attack and devour the sun-fish before it can gain access to the stomach and intestines of the final "host." Although the mature condition of the joints or proglottides of *Tetrarhynchus reptans* at present remain unknown, it is quite certain that, no matter how long the immature strobila remains within the sunfish, it cannot attain sexual maturity until it is transferred in the manner pointed out. This law in the development of tapeworms appears to be universal, and as such was, we believe, first recognised by Von Siebold. Another and more familiar illustration of its application is seen in the development of the *Cysticercus fasciolaris* in the liver of the mouse. It is not uncommon, in old mice especially, to find this cysticercus developed into a strobila or tapeworm several inches in length, whilst it is still coiled within the liver, but if the joints be examined, none of them will be found to contain reproductive organs, or even indications of them; as soon, however, as the cat—the final "host" of the parasite—swallows the mouse, the cysticercal condition of the immature tapeworm immediately disappears, and fresh joints are formed, which become sexually mature; in this state the strobila is recognised under the title of *Tænia crassicollis*. In regard to the question as to whether the boring of the young tapeworms through the flesh and viscera of the first "host" gives pain or otherwise, we cannot of course speak with absolute certainty, but from the slowness of the process and the extreme minuteness of the boring apparatus, we think it very doubtful if the presence of the parasites is even felt at all. When, however, there are many of them, and they have by their complex and long-continued movements injured the secreting structure of the liver, we think they give pain indirectly, as it were, by causing the decay of that organ and the consequent enfeebling of the vital powers of the "host." It is at such a time that the sunfish would be easily overcome by its natural enemies, and the piscine life would thus be sacrificed for the advantage of the long-imprisoned guests. The Tetrarhynchi are passively transferred into the alimentary canal of their final "host," and, so far as our observations extend, we know of no instance where the young tapeworms escape by themselves from the body of the first "host" before they complete their final development.

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HONEY, ITS ORIGIN AND ADULTERATION.*

BY W. W. STODDART.

HONEY is so familiar an object, and so well known to the youngest child, that it has become quite a household word. It has had its praises from every author and poet, from the sacred writers to the present day; and yet it is very surprising how little mention is made in any chemical or botanical work of the changes that take place in its elimination, of its origin, or even of its composition. Like the foreigner who consulted Johnson's Dictionary, the more he searched the more he was puzzled. Fownes, Turner, Gregory, and Stockhardt simply state that the solid crystalline portion of honey is grape-sugar, but say nothing of the liquid. Johnston in the first volume of *Chemistry of Common Life*, says "Honey is formed or deposited naturally in the nectaries of flowers, and is extracted therefrom by the bees. When allowed to stand for some time, it separates into a white solid sugar, consisting of white crystals, and a thick semifluid syrup. Both the *solid and liquid sugars have the same general properties*. The solid sugar of honey is identical with the sugar of the grape."

Dr. Hassall, in the article on honey, in his *Food Adulterations*, after quoting the above, says that the regularly-formed crystals, myriads of which are present in honey, are *identical in form with cane-sugar*. Such is the drift of the whole information that can be gathered respecting the composition of honey.

On dissecting the honey bee, we find the proboscis continued into a beautiful ligula or tongue. It is a flexile organ, covered with circlets of very minute hairs. The ligula of the honey bee differs from that of the other divisions of the bee family (the Andrænidæ) both in shape and microscopic appearance. It is probable that the bee uses the ligula, by inserting it in the nectar, which would be plentifully collected by means of the hairs before-mentioned. These hairs very likely answer a somewhat similar purpose to the teeth of the molluscan tongue. At the base of the proboscis commences the œsophagus, which, after passing through the thorax, terminates in an expanded sac, termed the honeybag. This is an elastic glandular organ, placed before the entrance to the true stomach. Into this sac the saccharine fluid enters after being swallowed. Should, however, any more solid substance be present, it is forwarded into the true stomach for trituration by the numerous

* The author read a paper on this subject before the Bristol Miscroscopical Society.

teeth with which it is furnished. The honey gland also secretes a peculiar acid to be mentioned presently. The bee retains the fluid portion in the honey sac till the proper time should arrive for deposition in the cell of the honeycomb.

Before describing the floral fluid and its transition into honey, it will perhaps be better to briefly describe the appearance under the microscope of the different sugars that are connected with the present subject. These are of three distinct kinds.

Cane-sugar (sucrose) $C_{12}H_{11}O_{11}$, Grape-sugar (glucose) $C_{12}H_{12}O_{12}2HO$, and Manna-sugar (mellitose) $C_{24}H_{24}O_{24},4HO$. A fourth kind (fructose) is mentioned by some authors, but requires more confirmation before it can be regarded as a distinct sugar.

Cane-sugar is the well-known crystalline substance usually procured from the cane, but is found occurring in beetroot, Indian corn, the lotus bean, and many other vegetables and fruits. When pure, cane-sugar forms very fine oblique rhomboidal prisms, with dihedral summits. When crystallized on slides for the microscope, it always has a tendency to form flat bold crystals, which usually are so connected one with another as to cause a mass, which, when large, is commonly called sugar candy. Cane-sugar, when in contact with vegetable acids, has always a strong disposition to change into the second kind of sugar mentioned (grape-sugar). So much is this the case that the author has never yet found cane-sugar in a natural state unaccompanied by traces of grape-sugar.

Grape-sugar (glucose) is the sweet substance found in the grape, dried raisins, diabetic urine, and wherever cane-sugar has been formed. Besides differing with chemical re-agents, grape-sugar has not the slightest resemblance under the microscope to that from the cane. It crystallizes generally both from water and alcohol in tufts, which consist of lamellæ radiating from a centre. The author has slides in which glucose has crystallized in perfectly regular six-sided prisms, but these instances are very rare. When a solution is hastily evaporated, the crystals are beautifully dendritic. Glucose is formed in plants by the addition of three equivalents of water to one of sucrose, which change is caused by the continued increase of warmth, action of acids, or a principle called diastase, or all combined. For sugar being an organic body, like all such in the living tissues is constantly undergoing changes.

The third variety to be mentioned is manna or mushroom-sugar (mellitose). It is formed always during the fermentation of cane, or grape-sugars. In old honey it exists in much greater proportion than in new. It crystallizes in long four-sided prisms. Mellitose differs from sucrose and glucose, in

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being nearly incapable of fermentation, and is by these means obtained from honey for examination. A very remarkable fact is that manna-sugar occurs in many of our seaweeds, as Fucus vesiculosus, Halidrys siliquosa, Laminaria saccharina, etc. The latter contains as much as twelve per cent. It may be detected also in the dandelion and celery plants.

All the sugars are splendid objects for the polariscope. A very beautiful method of exhibiting manna-sugar is by fusing a little on a glass slip over a spirit-lamp, and when cooling, touching three or four spots with the point of a needle, when circular crystals will form, showing the purest and most exquisite colours, rivalling the similar and well-known salicine slides.

At the base of the corolla of a flower, on the thalamus, is a part termed by botanists "The Disk." It is that portion which intervenes between the stamens and the pistil. It is composed of bodies usually in the shape of scales or glands. When examined at the proper season, they are seen to abound in a thick, sweet fluid, which, since the days of Aristotle and Virgil, has rejoiced in the name of "nectar." On this account the fruit yielding it received formerly the name of "nectary." Even in the present day those organs are the subject of much misapprehension. Linnæus and his followers gave the term nectary to any gland or organ for whose office they could not otherwise account.

The plants which furnish the greatest quantity of nectar, and therefore most liked by the bees, generally excrete it from the disk of the flower.

On many plants, however, as the ranunculus and fritillaria, a small glandular organ occurs at the base of each petal, and in which also nectar is enclosed, though not in such profusion as in the disk before alluded to.

As will presently be shown, this nectar is a simple solution of cane-sugar formed from the amylaceous sap of the flower and elaborated for the nutrition of stamens and pistil. What the bees find in the flowers is the surplus left when these organs have been supplied. The author examined every flower he could collect at the early season of the year (April and May) and found sugar in them all, whether furnished with disks, or nectariferous glands, or not; and came to the conclusion that sugar is necessary to the male reproductive organs of the flower, as it is in them chiefly to be found, the so-called nectariferous body merely serving the purpose of a reservoir.

M. L. Bravais, in a paper published in *Ann. des Sciences*, 2nd ser. vol. xviii. pp. 152, is of this opinion, and says:—The nectar-bearing parts occur rarely on the pistil or calyx, but generally on some part of the andræceum, always accompany-

ing the discharge of the pollen. He divides the stamen into four parts, which, reckoning from below upwards, are—1, the stalk, 2, nectary, 3, anther, 4, the limb, and makes out the nectary to be a filament carrying either secreting hairs, or glands, or a nectariferous horn. The author was unable to make out this subdivision satisfactorily.

The plants which in England are most attractive to bees are :—

Mignonette.	Rosemary.	Gooseberry.
Currant.	Lime.	Lemon Thyme.
Hazel.	Berberry.	Heath.
Wallflower.	Buckwheat.	Turnip.
Hollyhock.	Clover.	Winter Aconite.
Raspberry.	Willow.	Osier.
Broom.	Furze.	Borage, etc.

On examining an immature blossom of a wallflower, the vessels will be filled with an amylaceous fluid, which gives a distinct blue with iodine. After the lapse of from twenty-four to forty-eight hours, the flower having become much more expanded, and the stamens more mature, the fluid on being again tested will have a sweet taste, and give a dirty bluish-brown instead of a blue with iodine.

On cutting out the disks of several ripe specimens of wallflower, the author obtained a syrupy, clear, colourless fluid. This was mixed with a small quantity of distilled water, treated with lime and carbonic acid in the usual way, and filtered. The filtrate was then concentrated, and allowed to crystallize spontaneously on a glass slip. The result was a beautiful regular crop of crystals of cane-sugar, agreeing in their goniometrical measurements with that substance.

As the flower became more mature, the saccharine fluid was acted upon by the vegetable acids more and more, until at length when the ovary being fertilized, and the flower dead, a last examination showed the saccharine residue on the withered disk to be nearly all grape-sugar, almost incapable of being fairly crystallized.

The bee visiting the flowers when in their prime, inserts its ligula into the blossom, and laps up the greater portion of the liquid sugar, which after passing through the œsophagus is deposited in the honey sac. It here comes in contact with the secreting glands, which emit an acid which the author's experiments showed to be identical with formic acid. This it is which doubtless causes the peculiar tingling sensation at the back of the throat when much honey has been swallowed, and which is more perceptible to some than others. The bee after its arrival at the hive empties the contents of the honey sac into the comb, where it remains until the store of honey is taken. When separated from the comb, the purest honey is a

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clear, thick liquid, which after standing becomes thicker, till at length it "sets," as it is technically called. A small bit of this placed under a quarter of an inch objective, shows that this is owing to the grape-sugar (which has gradually been forming at the expense of the cane) crystallizing out in extremely thin, regular six-sided prisms. All the cane-sugar is retained in the liquid portion of the honey. This crystallization proceeds as the whole of the cane-sugar becomes converted into grape. When this takes place, so great is the proportion of crystals that the honey is said to "candy," and is not considered so good from the presence of acetic acid, which is produced by the grape-sugar, which in its turn undergoes a change through the agency of fermentation.

The honey crystals are not identical, as Dr. Hassall says, with those of cane-sugar. Although they greatly resemble the *summits* of regular prisms of the latter, yet the angles do not measure the same. Besides, cane-sugar always enlarges the sides instead of the summits, which are very much narrowed.

On more closely examining a slide containing a bit of old honey, besides the prisms will be seen small bundles of crystals. These are the manna-sugar. They remain after honey has been fermented, and may thus be separated. With these, small round or oval bodies will also be noticed spread over the field of the microscope, and are the pollen globules, showing in a beautiful manner from what flower the honey was collected. Of course they vary with every locality; but it is worthy of remark that a bee will only visit the same species of flower at the same journey; for the examination of a great number of bees will show that two kinds of pollen are never found on the same insect, although they may be very different on another working on the same flower bed. A single bee with all its industry, energy, and innumerable journies it has to perform, will not collect more than a tea-spoonful of honey in a single season, and yet the total weight of honey taken from a single hive is often from sixty to one hundred pounds. A very profitable lesson of what great results may arise from persevering and associated labour!

The evidence on which the author relied for the presence of formic acid was by distilling the honey and receiving the distillate in an alkaline solution. The resulting solution, after decomposition by an acid and evaporation, afforded all the usual reactions, and readily reduced the salts of silver.

The foregoing facts, therefore, clearly show that—

First. Honey is derived simply from a solution of cane-sugar identical in every respect with that from the sugar-cane.

Secondly. That it afterwards receives the addition of a small quantity of formic acid from the glands of the bee.

Thirdly. That the cane-sugar afterwards becomes gradually altered into grape-sugar by common chemical composition.

The flavour is of course quite accidental, and dependent on the aroma of the flowers the bees have visited.

For the purpose of illustrating the lamentable manner in which so useful an article as honey is frequently adulterated, the author exhibited four examples, all purchased in Bristol.

No. 1 was adulterated with cheap arrowroot and common brown sugar. The starch granules were easily detected under the microscope. The crystals of brown sugar were in considerable quantity, accompanied with the disgusting acarus, alive and in all stages of growth. It was remarked that in this and several other specimens the cane-sugar crystals present in the honey had no resemblance to the engravings in Dr. Hassall's work, nor in Dr. Lankester's *Half Hours with the Microscope*. Here the sugar had always the appearance of sugar-candy, or else flattened prisms, but totally distinct from the genuine honey crystals.

No. 2 had been lowered with brown sugar only, and in every respect resembled No. 1, minus the starch granules.

No. 3 was adulterated with pipeclay and turmeric. The peculiar cell structure demonstrated the presence of turmeric. The clay was easily separated by washing. The author exhibited a good sized button of pipeclay, which he had obtained in this manner.

No. 4 was adulterated with plaster of Paris and brown sugar. In this instance the gypsum was procured in the same manner as the pipeclay of No. 3. The usual chemical tests—barium and oxalic acid, proved its composition.

With all these honeys a considerable quantity of water must have been added, for they continued in a liquid state throughout the winter, without the slightest appearance of setting.

THE ORIGIN AND TRANSFORMATION OF ANIMALS.

During the years 1855 and 1856 M. Quatrefages published a series of articles in the *Revue des Deux-Mondes*, which he has now elaborated into a book entitled *Métamorphose de l'Homme et des Animaux;* and as this work deals in a succinct and agreeable form with questions of great interest, we propose in this paper to give an account of the principal results which are set forth in its pages. In distinct opposition to the school of Heterogenists—represented in France by M. Pouchet and in England by Dr. Grant—M. Quatrefages adheres to the maxim of the illustrious Harvey, *Omne vivum ex ovo*—"Every living

being from an egg;" and all the cases of eggless production he treats as phenomena of individual growth, assembling the entire group under the new-fangled and not very happy designation of *Geneagenesis*, or the "Generation of Generations." "Every living being," he says, "and consequently every animal, comes from a germ. With the organization of this germ commences a series of transformations, general or partial, rapid or slow, and which only terminate with its life." All animals likewise undergo transformations, which, considered radically, "are due to the same cause, and are effected by the same methods." The germs or first rudiments of living things may be referred to three types. Animals multiply by eggs and by buds, which are either permanent or "caducous."* The egg method may be regarded as "fundamental, and the distinction between oviparous and viviparous species, although still admitted in scientific phraseology, is in reality only nominal. Baër, in discovering the egg of the mammalia, M. Coste, in demonstrating that this egg possesses the same parts as the egg of birds, have established this fact, which has been put out of doubt by the profound researches of those two naturalists and by the admirable labours of English and German physiologists, Barry, Bernhardt, Bischoff, Wharton Jones, Valentin, Wagner, etc. It is now plainly demonstrated that the mammalia, including man himself, spring, like birds and reptiles, from veritable eggs."

Here the question arises, What is an egg? M. Quatrefages answers, "Three spheres enclosed one in the other and contained in a transparent membrane, constitute the germ." The egg may differ in accessories, but "we always find in the vitelline membrane the vitellus, or yolk, enveloping the *germinative vesicle of Purkinye*, which itself includes the *germinating spot* of Wagner. The precise functions of each of these spheres is far from being determined, but it is at least certain that the vitellus is especially composed of organizable and nutritive materials. In certain animals its alimentary provision is considerable: a small part suffices for the constitution of the new creature, which nourishes itself and grows at the expense of the rest." The fish, for example, comes out of the egg completely formed, and gradually assimilates the matter which his stomach has enclosed. Among the viviparous animals the vitellus is very small, and the embryo is nourished by materials obtained elsewhere. The oviparous creatures *lay* their eggs, the vivipa-

* This term is borrowed from the botanists. In Professor Henslow's valuable *Dictionary of Botanical Terms* we read "caducous (*caducus*, ready to fall) when a part falls off very early compared with other parts with which it is associated. Thus the sepals of many poppies fall as soon as the flower begins to expand." Caducous germs fall for the purpose of development.

rous retain them for internal development; but birds, worms, reptiles, and men, all are *hatched.*

The viviparous, and many of the oviparous tribes, resemble their parents as soon as they have passed the fœtal stage. The marsupial animals, such as the kangaroo, forming no real exception, as the seclusion of their young in the pouch is only a second act of gestation. In other species—all of them oviparous—the offspring, at the moment of leaving the egg, differs completely from both its father and its mother. It may possess organs which they have not, and be destitute of organs with which they are furnished, so that changes and metamorphoses are required to bring it back to the original type. M. Quatrefages proposes to restrict the term *transformation* to the designation of those changes which the germ experiences in becoming an embryo, or which it undergoes while still enclosed in the egg. *Metamorphosis,* in like manner, designates changes altering the character of the creature, and, occurring after it has left the egg, or been hatched. *Geneagenisis* refers to the changes which "affect the generations themselves."

In discussing the transformations of the egg, M. Quatrefages refers particularly to his own observations of the Serpula and Teredo. After the laying of their ova, the eggs, whether fecundated or not, exhibit an internal commotion; "a mysterious force agitates the yolk; granulations accumulate now at one point and now at another," so that the shadowy mass changes its aspect every moment. M. Quatrefages considers that similar changes take place in the eggs of higher animals although they may be slower, and more difficult to trace. In the Serpula and Teredo eggs the agitation causes the "Purkinje vesicle" and the "spot of Wagner"—to disappear. If the eggs have not been fecundated, the movements become accelerated and irregular, and, finally, decomposition ensues. All through the animal kingdom the male element appears to excite and regulate the germinating force. In the eggs of the creatures named, a little nipple appears on the surface of the altered yolk, from which one or two transparent globules are expelled, the use of which is unknown.

This occurs whether the eggs have been fertilized or not. If fertilized, the expulsion of the globules is succeeded, "whether it be in the mammalia or the serpulæ," by a short period of repose. When activity recommences constrictions become visible, and the yolk assumes a mulberry aspect. The details of the process vary in different animals, "but in all, the consequence of the phenomenon is the formation of a primitive organized layer which envelopes the yolk, and is called the *blastoderm.* As soon as organization begins, it assumes distinctive characters; "the germ becomes the embryo, and from its origin reveals the

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fundamental characteristics of the group of which the new creature will form a part."

We must refer the reader to M. Quatrefages' agreeable volume for further details on this branch of the subject, and pass to the consideration of a few points in the development of the egg of the mammalia. Here our author tells us the heart soon makes its appearance, accompanied by arteries and veins, and soon after it the nervous system, the digestive tube appearing more late. This order of succession is directed by the method of nutrition, and it is inverted among the invertebrata, where the digestive apparatus precedes the circulatory. In watching the process of transformation, "every day, every hour, the scene changes, and this instability effects essential as well as necessary parts, etc. . . Here cavities partition themselves into distinct chambers, or extend themselves into canals; and these, in their turn, are filled up and converted into ligaments; films are rolled up into tubes; isolated parts solder themselves together into continuous organs, or uniform masses divide themselves and form several organs. At the same time, relations and proportions change each instant. Parts which had been almost confounded, separate and become strangers; others, which had been separated, approach and contract intimate union. Organs with temporary functions, grow, increase rapidly, acquire an enormous size, and then become atrophied, and disappear. Others stop at a given moment, while all grows around them. They retain their place, and will be found in the adult, where they have no other apparent part than to bear witness to a state of things which no longer exists."

Having got out of the egg and been born, the young mammal experiences *transformations*,* the proportions of the several parts altering at each stage, that of puberty being highly interesting and important. MM. Andral and Gavarret state that at an early age boys and girls respire with equal vigour. Before puberty M. Quatrefages calls them neither males nor females, but neuters. "But as soon," he says, "as the sexes are characterized, the respiration of the young man exhibits a redoubled and rapidly augmenting activity, while in the young girl and young woman this function remains stationary. About the age of thirty the former burns† about one hundred and seventy or a hundred and eighty-six grains of carbon in an hour. Subsequently, when the progress of age, and its accompanying transformation, cause the two sexes to approach by effacing their more salient characteristics, the respiratory activity of the

* M. Quatrefages entitles the chapter from which these remarks are taken "Transformations des Mammifères hors de l'œuf." Thus he does not follow the nomenclature which he recommends, and according to which these changes would be metamorphoses.

† The non-chemical reader may be reminded that respiration is a process of combustion.

woman comes nearer to that of the man, but without reaching so high a limit."

From transformation we pass naturally to metamorphosis, and we find that the larva of an insect or crustacean may be regarded as an embryo with an independent life, which obtains its own food instead of being nourished by its mother, and which undergoes before our eyes transformations analogous to those which the young of viviparous creatures experience inside the maternal organism. A proximate cause of metamorphosis may be found in the small amount of organizable material supplied by the yolk of the eggs of creatures which exhibit its peculiar phenomena. In common language, the more imperfect the condition in which the egg turns out its inhabitant, the more extensive the changes which the creature must afterwards undergo. M. Quatrefages observes that, compared with the eggs of certain molluscs, those of insects are enormous. Thus, the egg of the *Cossus ligniperda*, which Mr. Noel Humphreys discoursed of in our last number, is about "thirty thousand times bigger than the egg of a teredo." We cannot therefore be surprised that from the former there emerges a caterpillar or animal of a complicated construction, while the ovum of the teredo yields only a simple creature, "a homogeneous pulp, in which a digestive tube is vaguely discerned. The first has to fabricate certain organs, but its chief work is to develope and and modify those which it possesses, while the last has everything to acquire." In contemplating the changes which we can observe in the lower vertebrates or molluscs we are insensibly led to the philosophy of the case. If we observe the gills and tail of the tadpole disappear, we must, as M. Quatrefages says, exclaim, "Here are organs that become atrophied or dwindle." If we compare the abdomen of a young crab with that of the adult animal, we conceive the idea of "arrested development," and if we observe the Lernea* having its limbs, which first acted as oars, changed into a kind of anchor to fasten it to its prey, we cannot but admire the way in which nature appropriates an existing organ to a novel use, and we find the idea of "transformation." In these and similar transitions there is nothing violent, but all goes on in measured order and progression. In our author's words, "the gills of the tadpole do not fall off to make room for lungs; the tail is not detached, because the legs are ready. No; as the one pushes on its growth, with bones, muscles, nerves, and vessels, the other diminishes in all its parts. Molecule by molecule the one is absorbed; molecule by molecule the other is built up." The moults of crabs and other crustacea do not prove exceptions to this rule, for although the actual change of the hard integu-

* Described by Mr. Brady, in our July number.

ment appears sudden, the internal processes which lead to it have been gradually carried on. Among insects the larva prepares the materials which the chrysalis will require; it has, so to speak, stored up in a magazine the materials necessary for its transformation.

We now come to the class of facts which M. Quatrefages groups together under one term, "Geneagenesis." As our readers will probably know, those vexatious inhabitants of the greenhouse or garden, the plant-lice, or *Aphides*, produce a series of offspring without the conjunction of two sexes, and in this mode of proceeding, Bonnet discovered unexpected facts. "He found that all through the fine weather the aphides reproduce their race, if isolated, but when the temperature falls, these animals, returning to ordinary conditions, propagate by eggs which demand the conjoint action of a father and a mother. These eggs pass the winter glued to the branches of the trees on which the colony dwelt that was destroyed by the cold. When they are hatched in spring they yield *viviparous* individuals only; in the autumn males and females appear, and from this moment *oviparous* generation recommences its work." It would have been impossible to place these curious incidents in their true position if Trembley and others had not observed that polyps and similar animals of simple structure can propagate like vegetables by buds. It was also necessary that Chamisso should make his discovery that the Salpæ produce their offspring in the strange fashion which he characterized as the "alternation of generations;" and here we cannot do better than borrow M. Quatrefages' description of a salpa, for the benefit of those to whom this interesting inhabitant of our seas is unknown. He says: "Salpæ are marine molluscs of a very queer shape, which it is difficult to describe. We may, however, figure one as an irregular crystal cylinder, perfectly transparent, in the interior of which is suspended a proportionably small mass of opaque lively coloured matter, called the *nucleus*. This is formed by the junction of the principal *viscera*. The cylinder represents the mantle and the shell of ordinary molluscs, and it is pierced towards each extremity. The water necessary for its respiration enters at one of these apertures and is expelled from the other, thanks to the contractions of the mantle; and making its exit with rapidity, it pushes the animal in an opposite direction, so that the creature swims solely by means of its respiratory movements." For a long while the attention of naturalists was drawn to these objects, "whose phosphorescence was remarkable even among the fiery waves of the intertropical ocean," and they sometimes discovered them in an isolated condition, and sometimes in chains. It was Chamisso who explained this riddle. He saw that the Salpæ were androgynous (bisexual) and

viviparous; that they came into the world in the shape that they preserved all their lives; and that, strange to say, a solitary mother only brought forth infants united in colonies, and these in their turn engendered only solitary individuals. It followed from this that a Salpa never resembled its mother or its son, but always its grandfather or its grandson." Upon this curious state of things, M. Quatrefages remarks that "metamorphosis here influences generations and not individuals, and matters proceed as if the caterpillar, instead of becoming transformed, gave birth to complete butterflies, which in their turn reproduced the caterpillars."

It is, in fact, a case of the alternation of generations, the precise nature of the process being left for Krohn, Huxley, Leuckhart, and Vogt to elucidate. Before completing this curious story, let us follow M. Quatrefages, and advert to a similar set of incidents in the domestic manners of the Medusæ, or jelly-fish. "For more than a century," as he tells us, zoologists had admitted among the other great divisions of the subkingdom of the Radiata, the class of Acalepha, or medusa (sea nettles, jelly-fish), and that of polyps. This distinction seemed more than justified, as differences between the two groups were detected, more profound, and more numerous than those which separate the reptiles from the birds. There was in fact no resemblance in external aspect or internal organization. The jelly-fish, or Medusæ, for example, are free swimmers, and mostly solitary; while only a few polyps enjoy a crawling motion, nearly all are fixed, and most of them live in colonies. Notwithstanding these and other differences, the two classes approximated as their history became known. "The medusa lays eggs, well characterized by the existence of three concentric spheres, of which we have already spoken. These eggs transform themselves into larvæ, which at first differ little from those of the Serpula or the Teredo. Their oval and apparently homogeneous bodies are covered with vibratory cilia, and exhibit a small depression in front. They swim for some time with vivacity, like the infusoria, which they resemble sufficiently to deceive any one whose observations were restricted. This first phase of the life of a Medusa lasts about eight and forty hours. The movements then grow slower, the young larvæ seem fatigued, and by the aid of the little depression attach themselves to some solid body. Henceforth the wanderer vegetates in one spot—a thick mucous which it secretes forms a large disk that fixes it firmly.* The young Medusa changes its shape as well as its mode of life. It elongates rapidly. Its

* In a note M. Quatrefages says that he has reproduced the opinion of Sars, although he thinks it probable that the so-called mucous is a veritable expansion of the sarcode.

pedicle grows narrower, and its free extremity swells out in a club form. Soon an opening appears in the middle of this extremity, and an internal cavity is seen. Four little nipples spring from the margin, and grow into arms, while others are not slow to appear, and elongate in their turn. The infusory of yesterday is changed into a polyp." In this state it exhibits the properties and ways of the polyp group, multiplying by buds and by *stoles*,* from which new polyps arise. The formation thus produced resembles "horns widely expanded, but short, and having their margins garnished with twenty or thirty slender and moveable filaments." M. Quatrefages compares this mode of growth to the proceedings of a strawberry plant, and thus continues the story. "The Medusa lives some time under this form, until at last, one horn acquires three or four times the length of its companions, and at the same time becomes cylindrical. A circular depression then forms near the crown of tentacles, others follow at regular intervals towards the pedicle, which is never reached. The body thus becomes circled with ten to fourteen rings." After undergoing development, these rings are successively detached, and swim away. They are in fact medusoids, and gradually assume the true medusa form. These remarkable steps are again compared by M. Quatrefages to an imaginary case in the insect world. Suppose, for example, "a butterfly laid an egg, that from this egg there came an earthworm, which changed into a caterpillar, from which other caterpillars grew like branches. Suppose, then, that each caterpillar retained its head, but suffered its body to be transformed into a chrysalis; that the body was then constricted at intervals, and that it gradually appeared to be composed of butterflies piled one on the top of another; that the head subsequently fell off, and the butterflies flew away and gradually assumed their full proportions and perfect forms." This certainly would be an incredible narration, but transfer the incidents from the insect world to the jelly-fish, and it is pretty much what actually takes place.

The interpretation of this class of facts renders it necessary to bear in mind the words *larva*, *chrysalis*, and *perfect insect*, and to remember the conditions which they indicate. Turning to the classes of animals undergoing the peculiar changes which we have traced, M. Quatrefages proposes to adopt the nomenclature of Van Beneden, and to "call *scolex* the animalcule which emerges from the egg of a medusa, or any other species following the same method of reproduction. Extending the

* "Stole (*stolo, a shoot*), a lax trailing branch given off at the summit of the root, and taking root at intervals, whence fresh buds are developed."—Henslow, *Dictionary of Botanical Terms*. Zoologists borrow this term to describe an analogous process in certain animals.

meaning assigned by Sars to the term *strobila*, it will designate every compound being which proceeds from a scolex, and which is destined to produce isolated individuals. Lastly, borrowing from Dujardin an expression which he employs in a similar sense, *proglottis* will designate the individuals springing from a strobila, and which complete themselves by the acquisition of reproductive organs, and thus close the cycle of development." Between the primitive *scolex* and the *strobila* several generations may, as we have seen, be intercalated, and in this case our author calls the first scolex *proto-scolex*, the second *deuto-scolex*, and so on, signifying first, second, etc. by Greek words.

In the medusa, we saw that "each egg which it laid, produced not a single medusa, as a butterfly's egg yields a single butterfly, but a great number of individuals. Secondly, this reproduction took place in an indirect or mediate way; for between two generations of medusa, several generations of very different creatures were produced by budding. To speak in a still more general way, it is a case of *multiple generation* by the aid of a *single germ*. It is that which I have endeavoured to express by the word *geneagenesis*, which is applicable to every method of reproduction that exhibits this characteristic feature." The common polyp multiplies by buds, and also by eggs; but when it lays eggs it dies. Thus from the polyp egg comes a single individual, a *scolex*, capable of producing others like itself, which can bud in their turn and repeat the process, and which end, like the original stem animal, in acquiring sexual attributes. "It is as if there came from the egg of a butterfly, an animal having the appearance of a perfect insect, but destitute of reproductive organs, although able to give rise by budding to individuals like itself, and which, together with itself, would ultimately acquire the attributes of a father and mother." In such instances geneagenesis is reduced to its simplest elements, each scolex transforms itself into a proglottis, and the strobila stage does not appear.

Among the ascidians, of which the Salpa may be taken as an example, "the scolex transforms itself directly into a proglottis which in its turn produces a whole generation of individuals like itself. . . . . In this case, to follow our comparison, it is as if the butterfly's egg produced a caterpillar which arrived at a perfect state, and afterwards from the butterfly coming from the primitive egg, other butterflies had sprung, of which it was neither the father nor the mother, but only the parent." With the plant-lice we arrive at further complications. "The egg laid in autumn engenders a scolex having the character of a nymph or pupa. During the spring this nymph does not lay eggs, but forms *buds* which arise and organize themselves in the *interior* of its body, instead of making their appearance and

developing themselves on the outside, as with the polyps and the medusæ. When the temperature falls, the normal reproductive apparatus shows itself in distinct individuals, and then we find males and females, that is to say, true *proglottis.*" M. Quatrefages does not consider that the main facts demand any other interpretation, in consequence of Heiden's discovery that an aphis, after producing offspring all through the season *agamically*, or in a spinster state, ends in acquiring sexual characteristics. This he calls the *scolex* becoming a proglottis.*

With reference to the Salpa and its curious "alternation of generation," M. Quatrefages observes: "Thanks to Messrs. Krohn and Huxley, we now know that with the Salpæ there is not only an alternation in form and condition, but also in the method of reproduction. From their united labours, it appears that the *chained* Salpæ are at once males and females, and that they lay eggs from which the *isolated* Salpæ are produced. These last are neuters, and give rise, by internal budding, to chained Salpæ only. . . . Among the Salpæ it is as if the egg of a butterfly produced a caterpillar, from which sprung a chain of butterflies fastened together, and flying without power of separation."

The phenomena of geneagenesis are confined to the lower grades of the animated world: no vertebrate animal exhibits them, and they are rare amongst invertebrates of an elevated organization. Independent of the plant-lice, insects rarely furnish instances of this peculiar mode of multiplication, and M. Quatrefages tells us that among the superior annulated animals, or those possessing articulated feet, it is only found among insects and crustaceans. "Moreover, among these latter we have no other example than that afforded by the Daphina; at least nothing of the kind has yet been noticed in the myriopods, spiders, and cirrhipedes.†

Among the worms, or inferior annulated animals, it is commonly found, and M. Quatrefages regards *fissiparity* or multiplication by division as belonging to this system of reproduction. He observes, with special reference to Nais, Nemertes, and other worms, "During many generations the individuals produced by this method are neuters like their parent; at length, under conditions which are not known, the sexes appear, and the species is propagated afresh by means of eggs." He adds, that no mollusc, properly so called, adopts this mode of propagation, but that among the *molluscoida* (or mollusc-like creatures) geneagenesis seems to be the rule.

* Detailed information concerning this subject will be found in Mr. Huxley's paper on the *Organic Reproduction and Morphology of the Aphis. Linn. Trans.* 1858.

† The Scolopendra, or "Hundred Legs," common in gardens, is a myriopod; the acorn barnacle, so frequent on seaside rocks, is a cirrhipede.

We must refer the reader to the elegantly written work upon which this paper is founded, for details of the reproductive arrangements of the Radiata, and intestinal worms; suffice it to say, that among all the diversities which they present, the author traces the leading facts of his doctrine of geneagenesis, and feels justified in arriving at the conclusion that gemmiparous or budding reproduction is not able to perpetuate the species, but that after a given time the formation of true eggs becomes necessary. He rejects the Parthenogenesis, or Virgin-generation doctrine of Mr. Owen, and sees in all the cases to which such an explanation has been applied, illustrations of the methods we have explained. With the views of Dr. Carpenter he concurs, regarding oviparity or egg generation, as entirely distinct from gemmiparity or bud generation; the first demands the concurrence of two systems of organs, special and distinct; the second, as Dr. Carpenter expresses it, is a multiplication of cells by a process of continual growth. All reproduction that does not involve the formation of true eggs he regards as phenomena of budding, which in their turn are phenomena of growth, and as the manifestations of growth are limited, the budding process has its duration limited also, and can never perpetuate a race.

M. Quatrefages is of course aware of the difficulty of proving the intervention of a *father* in all cases of continuous reproduction in the insect world. As we have seen, the necessity for such an individual may be postponed for many generations, and some naturalists have thought it might be permanently dispensed with. It may be asked, Is the father a constant item in the natural arrangements for the preservation of species? Bernouilli, Treviranus, Suckow, and Burmeister had observed among several nocturnal moths, and Malpighi, Herold, Curtis, and Filippi had noticed among the silkworm moths, that females without any connection with the males of their species could lay fertile eggs, and M. Carlier has obtained three virgin generations of the *Liparis dispar*.

These observations seemed little favourable to the pretensions of the male sex, but subsequent discoveries reasserted its importance. M. Zierzon, curé of Carlsmark, in Silesia, a man whom M. Quatrefages describes as endowed with a rare faculty of observation, declared that while the Queen Bee preserved her virginity intact, she could only lay eggs that produced *males*. He admitted with Huber that the queen could receive on a single occasion enough of the fertilizing fluid to last for several years, but he contended that she could decide whether the egg which she laid should be acted upon by it or not. In the first case he said a female bee was the result, and in the latter a male. It appears that with bees the union of the two sexes

can only occur during flight, so that cutting off the wings of a female bee, or a natural defect having the same result, will preclude her laying fecundated eggs. It also appears that if a married queen is exposed to a degree of cold capable of injuring the fecundating fluid, or if the communication is stopped between the vessel in which she retains it, and the canal through which the eggs are deposited, she only produces males *after* such an accident, although she had previously been producing bees of her own sex. In Germany, where bee culture occupies much attention, it seems that efforts to produce crosses between two races confirmed Zierzon's ideas. Thus when local bees were crossed with the Ligurian bee, the offspring resembled both parents so far as workers and queens were concerned, but the male progeny reproduced the maternal type in all its purity. Siebold and Leuckart undertook a scientific examination of the facts thus disclosed by Zierzon and Berlepsch, and the result of *post-mortem* examinations of married and unmarried queens, and of the eggs which they produced, showed that the curé of Carlsmark was right.

At this point of the argument the question arises whether the unimpregnated eggs are true eggs at all. To answer this M. Quatrefages has recourse to the labours of Mr. Huxley in reference to the reproduction of the aphides, and he observes, "in the three last chambers of the ovary of the *oviparous* aphis, figured by Huxley, we see the egg in its nascent conditions, represented only by an isolated vesicle of Purkinje, very small, but well characterized and already possessing the spot of Wagner. This vesicle grows in passing through the second chamber, but it is only in the third that it begins to surround itself with a vitellus, all the while leaving the germinating spot distinct and noticeable . . . . with the *viviparous* aphis, Huxley describes and figures these phenomena very differently. Here the last chamber of the ovary is filled with a pale homogeneous matter, in which are a dozen cells with opaque nuclei.* A portion of this matter is separated from the rest by a constriction of the walls of the chamber, which becomes more and more pronounced. . . . . Nothing here resembles the true "vesicle of Purkinje," or the true "spot of Wagner,"—"the fundamental elements of eggs properly so-called." Acting upon this view, M. Quatrefages considers the unfecundated eggs to be another form of *bud*, and he asks, "is their nature changed because, being destined for development outside the maternal bosom, they have received an envelope of greater or less solidity according to the protection against accidents which they are likely to require in the external world? . . . . . But if these reproductive bodies are *buds* not *eggs*, it follows that

* "Dans laquelle sont comme noyées une douzaine de cellules à noyau opaque."

development without male intervention belongs to the phenomena which we have been studying, and that we have thus not *parthenogenesis* but *geneagenesis*."

Regarding no object as a veritable egg which does not possess the Purkinje vesicle, and the Wagner spot, M. Quatrefages considers that cases of parthenogenesis will be greatly diminished, but he is convinced they will not be entirely obliterated from the book of science. He admits, without, as he says, going as far as Huxley, Owen, and Lubbock, that there exist "intermediaries" between eggs and buds, but after all reservations, "parthenogesis is not in his eyes a constant fact." He admits that there exist "true females laying veritable eggs which develope themselves without male intervention in any way whatever;" but he thinks these phenomena are supposed to be much more frequent than is really the case, and that reproduction by females only, tends to exhaust itself, and that "always, the intervention of the male, recurring at a given moment, as a necessary element in the perpetuity of species, is evidently one of the great laws of nature." The father is thus "as necessary as the mother for the indefinite duration of species, and the point of departure for a cycle of generations is not only an egg, but a fertilized egg." *Parthenogenesis* is then "only a particular case of *geneagenesis*."

We cannot now follow M. Quatrefages through the vegetable kingdom in which he pursues his theme, but we may observe that philosophers, who require every step in an inductive process of reasoning to be strictly proved, will hesitate before they affirm with him that "a father and a mother—that is a male and a female—such is the origin of *every* living being." They will likewise prefer a frank confession of ignorance as to how and why the characteristics of individuals descend to their posterity, to the assertion that "an *essence* proper to the character of each being" is received from its ancestors and transmitted to its posterity. All, however, will allow that M. Quatrefages has produced an admirably written and learned work, which supplies the profoundest naturalist with deep matter for investigation and thought, while from the elegance of the language and the clearness of the style, it is admirably adapted for popular use.

XUM

CHEMICAL MANUFACTURES, AS ILLUSTRATED IN THE EXHIBITION OF 1862.

BY J. W. M'GAULEY.

It is probable that in no department of the Exhibition is the progress of Science more clearly demonstrated than in that which is devoted to chemical products. The various substances which are found there, and the different compounds, are so conveniently classified, and the specimens themselves are, in many cases, such beautiful objects, that a careful inspection of them is attended with both profit and pleasure. What can be more agreeable than the brilliantly white crystalline masses of sal-ammoniac, alum, etc., or more pleasing to the eye than the rich colours of the chromates and sulphates of copper, prussiates of potash, and many other salts. And if perfect crystallization, and either richness of colour or total freedom from it are to be considered as proofs of the purity and excellence of the products, what are shown on the present occasion must be admitted to be inferior to nothing that has ever before been exhibited. The illustrations of chemical manufactures presented to the student are particularly valuable, not only because he can examine them without fatigue or trouble, on account of their excellent arrangement, but because he will see collected together a variety of substances with which he could scarcely have been acquainted except by name. He will find also, in several instances, the different phases of important manufacturing processes placed before him, so that he can trace their progress from their earliest stages to their completion. No branches of industry have derived more benefit from science than those which depend on chemistry. Not only have long-established operations been extended by it, and augmented in usefulness through a greater economy of production, but altogether new ones have been originated and developed. The degree to which the cost of many useful matters has been diminished is truly surprising: not to mention acids, and alkaline salts, which, in our own time, were so much dearer than at present, there are a number of compounds, the prices of which bear no proportion to what they were at no distant period. Thus Prussian blue was originally two guineas a pound; it is now less than two shillings. Ultramarine, when made from lapis lazuli, was five guineas an ounce; what is just as useful may now be had for little more than a shilling a pound.

We propose to treat, on the present occasion, of the manufacture of mordants and dyes: but the subject is so extensive that we must confine ourselves to a comparatively limited view

of it; and therefore we shall select for consideration only alum from the former, and madder, with its products, and the aniline colouring matters, from the latter.

Alum was well known to the ancients; it is mentioned by Pliny in his *Natural History*, but there is reason to believe that he did not restrict the word to the sense in which we understand it:—in his time sulphate of alumina, combined with more or less sulphate of iron, was also termed alum. From a very early period alum was used as a mordant, and also to render wood and cloth incombustible. It was obtained most abundantly, and of the best quality, from Egypt, and its name is probably an Egyptian word. Until the fifteenth century it was imported from the East, and was not made in England until the reign of Elizabeth. Our alum is essentially a double salt, one of its constituents being sulphate of alumina, and the other the sulphate of an alkali; and as there are three alkalis there are three corresponding alums. These are not, however, the only salts to which the name is given; every double salt constituted like an alum being considered such. Thus, in an alum, the sesquioxide of alumina may have been replaced by the sesquioxide of some other metal—as that of chromium, for example, or of iron; and in this way a great variety of alums may be produced; but each of them contains twenty-four atoms water. The alum in which alumina is replaced by oxide of iron, is used in Germany and other places as a mordant for logwood, galls, sumach, etc. Alum is found native, but almost all of the vast quantity which is used in dyeing, and for other industrial purposes, is artificial, being produced from alum stone or slate, schist or clay. Alum stone contains all the constituents of alum, but, in addition, certain impurities, which must be removed; schist contains only the alumina and sulphur; the latter must be oxidized, and an alkali must be added; clay requires the addition both of sulphur and an alkali. Alum stone is not abundant, but it yields alum by a comparatively simple process, and with a facility dependent on the proportions of its constituents. To obtain its alum, merely moistening it with water would suffice, but this is not the method adopted: in practice, sorted pieces of it are calcined, to deprive the free alumina present of its water, and thus destroy its affinity for the alum, with which it is in union. After which, they are exposed to the atmosphere, which causes them to fall into powder, and the alum is then dissolved out with water. The degree of heat to which the stone is raised, during calcination, is a matter of great importance; if this is too high, alum will not be formed; if too low, the result will not fall into powder.

Alum slate and shale are the most abundant sources of alum. Some of the alum shales, on being moistened with

water, heat and fall into powder; but most of them require to be roasted. If the bituminous matter they contain is too little for this purpose, small coal, or some other combustible must be added. The roasting deprives any pyrites that is present of half its sulphur, which passes off, either free or as sulphurous acid, sulphuret of iron being formed. This sulphuret, by attracting oxygen, becomes sulphate, which, as the temperature rises, becomes peroxidated, and yields its acid to the alumina. If, in roasting the schist, the heat is allowed to become too great—and, when the mass is very large, this is very likely to be the case—the sulphuret of iron will form a slag with the earth, or too much sulphur will pass off, and, in either case, waste will occur; the more moderate the heat, within certain limits, the more abundant the alum product. After calcination the mass is so porous, that the air can circulate freely through it; to facilitate this, and also to remove the sulphate of alumina, water is sprinkled upon it. When all the alumina is obtained in solution as a sulphate, the liquid is concentrated by evaporation: and, on adding an alkali, alum precipitates as a crystalline powder, which is purified by washing with cold water, in which it is nearly insoluble: being then dissolved in just enough of water raised to the boiling point, the solution is run into casks with moveable staves. When the whole has cooled, the staves are taken asunder, and the alum appears to be a solid mass: but on making an aperture in it, the mother liquor flows out.

As the supply of shales is confined to certain localities, alum is manufactured also from clay. The difference of the process employed, in this case, consists in adding sulphuric acid after calcination, and removing the iron—generally as Prussian blue, with ferrocyanide of potassium; the alkali is applied in the usual way. When ammonia is used as the alkali, it is obtained from gas liquor. Ammonia alum has the advantage of precipitating from a less concentrated solution. Spence manufactures it on a very large scale, his products being, on an average, more than three hundred tons per week. He uses the carbonaceous shale of the coal-measures: and his process is so effective that instead of one ton of alum being made from sixty tons of oolitic shale, sixty-five tons of alum are made from fifty tons. He calcines in the ordinary manner, but with great care; and adds sulphuric acid to make up for the deficiency of that produced from the pyrites, introducing along with it the ammonia and its volatile salts contained in gas liquor, the fixed ammoniacal salt being subsequently liberated by lime. The precipitated alum powder is dissolved, not by boiling water, but by steam: and any basic alum (a subsulphate) subsides from the solution, which is crystallized in the usual way. The masses of alum,

thus formed, weigh about three tons; one of them (No. 605) is exhibited.

Alum is used in a variety of ways, but chiefly as a mordant, on account of the affinity of its alumina for both colouring matters and vegetable fibre, between which it forms a bond of union. When applied to calico-printing, it is very important that it should be free from iron; and the chief use of the alkaline sulphate which it contains is to facilitate the separation of that metal, by rendering the aluminous compound so much more soluble as to allow the sulphate of iron to crystallize first, and be removed. When heated, ammonia alum loses first the whole of its alkali, and then the sulphuric acid passes off, pure alumina being left. The well-known superiority of Roman alum consists in its containing a considerable amount of cubic alum, which has a larger quantity of base than the octahedral; the extra alumina being held very feebly by the sulphuric acid, it is more easily detached as a mordant.

The use of alum has been in a great degree superseded by the employment of sulphate of alumina—incorrectly termed "concentrated alum." It is made from clay, contains but little alum, and is quite free from iron, that metal being easily and completely removed by ferrocyanide of potassium.

Madder is one of the most important substances used in dyeing, whether we consider the beauty, the variety, or the permanence of the colours it imparts; and it is specially deserving attention on account of the improvements which have been introduced into the mode of applying it. The plant from which it is derived is the *Rubia tinctorum* of Linnæus; and there is little doubt that its properties were as well known to the ancients as to ourselves. Other plants also, of the same genus, have been used for the same purpose. Thus, the *R. Manjista* has been employed in India from the earliest times for the production of the colour called *Turkey red:* and in the eastern parts of Europe the *R. Peregrina,* or *Alizari,* has long been used to obtain the same tint. Western Europe was, for many centuries, supplied with madder from Holland; but, on its being discovered that Dutch madder was incapable of producing all the colours which madder will give, it was imported from other places, and particularly from the south of France. Madder may be grown in England, but not economically. The *rubia tinctorum* is not an ornamental plant; its stem dies every year; but the root, which is the important part, is perennial. The Levant madder is the finest we receive; that of Avignon is next in quality. Cochineal imparts a richer tint than madder, but it is far more expensive. According to the mordants employed, madder produces every shade, from a pink to a deep red, and from a lilac to a black; and affords also va-

rieties of orange and brown. It is not used in dyeing silk. The splendid colour termed Adrianople or Turkey red, is produced with it by a very complicated process, which is practised on a large scale in France, and is considered there an industry of the highest importance.

It was formerly supposed that madder contains only a red and a tawny colouring matter; but it has been ascertained that it includes two reds, termed respectively by their discoverer *alizarine* and *purpurine*. It contains other colouring matters also, including two that are resinous, with sugar, acids, etc. If an acid is added to the brown muddy liquor, which results on treating madder with boiling water, a complicated precipitate is thrown down. When boiling water will extract no more colouring matter from madder, it will give out a large additional quantity if acted on with an acid, then washed, and treated with caustic alkali; and a precipitate may be thrown down as before by means of an acid. Nothing will then remain but woody fibre. Alizarine, or *madder red*, is found among the substances precipitated by the acid. It is always present in the madder of commerce, but is not to be discovered in the roots when first taken out of the ground. The cells of the living plant contain only a transparent yellow juice, which becomes red by exposure to the atmosphere, and has been termed *Rubian*. It is believed to be identical with the bitter principle, and, by means of an acid, to be convertible into different dyeing substances. If madder is treated with cold water, and the liquid is allowed to stand in a warm place, it loses its bitterness and yellow tinge, and gelatinizes; it is then capable of producing the most brilliant colours. The whole tinctorial effect of madder is not developed until the process of dyeing, when the gradual heat first applied causes the required fermentation of the rubian.

If the gelatinized cold solution is treated with alcohol, and the alcoholic solution is evaporated, a further heating will sublime alizarine in long brilliant transparent orange-coloured crystals. Alizarine may be obtained also by heating madder itself; but the product will be rendered impure by an empyreumatic oil. Although alizarine is of a reddish-yellow colour, its compounds are a beautiful purple or violet hue. It is precipitated from their solutions by metallic salts, etc., if in combination with the fixed alkalies; but spontaneously by the escape of the ammonia, if in combination with that alkali. Alizarine is dissolved without change by boiling concentrated sulphuric acid, and is set free from the solution by the addition of water. It has a very strong affinity for alumina; but if, in dyeing with it, bases are present, they will enter into combination with it; if acids, they will combine with the mordants.

It affords very readily a brilliant red with alumina, and a black or purple with iron; and very little of it is sufficient to produce shades of great intensity. Madder itself, if used for the same purpose, would require a tedious and complicated process.

Purpurine, or *madder purple*, the other red colouring matter, resembles alizarine, from which it may be separated by a boiling solution of alum, and, after cooling, may be thrown down by excess of sulphuric or muriatic acid. It produces, with mordants, a more fiery red, and a more intense black, than alizarine; but the purple it gives has a very disagreeable reddish hue, and hence its name has not been well chosen. Its colours are not only inferior to those of alizarine, but less permanent.

The precipitate thrown down by an acid from infusions of madder, contains also *rubiacine* or *madder orange*, a yellow colouring matter which sublimes in yellow crystals. It may be conveniently obtained by digesting washed madder roots for sixteen hours in eight parts of water at 60°, and straining the liquid, which will then deposit small crystals. When these, after having been dried, are dissolved in boiling alcohol, crystals will separate on cooling, and must be washed with cold alcohol. Rubiacine, as also the two resinous colouring matters contained in madder, injure the beauty of the dyes obtained from it, giving to the red an orange, and to the purple a red tinge, and a yellowish hue to those parts of the cloth which should be white.

It is a curious circumstance that madder, to produce permanent colours, must contain a certain amount of lime, either naturally or from its having been added. Hence dilute sulphuric or muriatic acid, injures its dyeing powers, but they may be restored. Something, therefore, depends on the soil in which the madder is grown, or on the water used in dyeing with it; if these do not supply the required carbonate of lime, the effect produced will be imperfect. Lime water neutralizes the injurious effects of the pectic acid, rubiacine, and resinous matters, in the madder; but excess of it would combine with the alizarine. If, in dyeing, only the latter is used, the smallest quantity of lime would be mischievous, since it would prevent the combination of the dye with the mordants, which are weaker bases.

Many unsuccessful attempts having been made to improve the colouring properties of madder, it was at length discovered that by acting upon it with strong sulphuric acid, and then washing with water, a more powerful and brilliant dye might be obtained. It is believed that the acid decomposes the bitter principle, producing new quantities of colouring matter; and that it liberates colouring matter which was in combination,

by rendering the earthy bases soluble, and therefore capable of removal. The subsequent addition of lime neutralizes the resinous colouring matters and other hurtful substances which the acid may have set free. When sulphuric acid is added to ground madder, all that is soluble in water can be extracted—including a large quantity of sugar, which is used for the manufacture of a spirit that pays for the whole process; since, though it is not drinkable, it answers well for varnishes. The dye stuff obtained in this way is termed *garancine;* it gives no colour to cold water; but, as it produces its whole dyeing effect at once, it is more powerful than the original madder; it affords brighter colours also, and does not stain the white parts of the cloth, which greatly simplifies the after-process. But, as the colours which it produces are less permanent, and do not so effectually, resist soap, etc., it cannot be so well employed for pink or purple. When the residue, after dyeing with madder, and the exhausted dye-liquor, are acted on with sulphuric acid, an inferior garancine, termed *garanceux,* is obtained; it will not give a good purple. The chief derivatives of madder, may be seen among the chemical products in the eastern annex.

But by far the most interesting manufacture connected with dyeing, is that which has for its object the production of colouring matters from coal-tar. The latter was long a reproach, both to the chemist and the economist, neither of whom, until within a recent period, applied it to any very useful purpose. It was generally consumed as fuel, the least profitable way in which it could be employed. Very valuable substances are however, now obtained from it, and among them *aniline,* which, with its compounds, has a special interest, on account of its capabilities as a source of colour, having been discovered long since the Exhibition of 1851. It is one of the bases discovered by Rungé, and was called by him *Kyanol,* but it has since been termed aniline, from the Indian name for one of the plants whence indigo, the substance from which it was first obtained, is procured. It may be had from a variety of sources, but most abundantly from coal-tar.

In the method of manufacture that is found most inexpensive and convenient, naphtha is first obtained by distillation of the tar; then benzole, by distillation of the naphtha, with certain precautions; nitro-benzole, by the addition of nitric acid to the benzole; and aniline from the nitro-benzole, by means of reducing agents. Two gallons of tar produce about ten grains of aniline. The various stages of this process are beautifully illustrated (No. 581) by the Messrs. Perkins, who exhibit also a mass of aniline purple, in the solid form, which is believed to have required for its production the tar from two thousand tons of coal; but it would impart a fine purple to one

hundred miles of calico, the solution required for the purpose containing less than a grain of the salt to the gallon. Aniline may be obtained also from naphthaline; and thus a substance which was so long not only worthless but a cause of considerable inconvenience, may be made the source of a most valuable material. The method of obtaining it from benzole was discovered by Bechamp in 1856. Its most characteristic property is the blue colour which it strikes with the solution of bleaching powder, or of any alkaline hypochlorite; and this suggested its use as a means of producing colouring materials. It forms crystallizable salts analogous to those of the metals.

The aniline colouring matters are generally obtained from its sulphate, which is formed by the addition of dilute sulphuric acid, and, with gentle evaporation, separates as a salt. The sulphate of aniline having been dissolved in boiling alcohol, it crystallizes in colourless plates, which become red by exposure to the air. *Mauve* dye, or aniline violet, is obtained by precipitating the sulphate with bichromate of potash, and digesting the precipitate with coal-tar naphtha; then dissolving out the colouring matter with alcohol, and removing the alcohol by distillation. Cotton does not take the aniline colours as well as wool or silk; they may, however, be found to answer better with Indian cotton, which from some cause, yet unknown, is more easily dyed than that from other localities. Among the derivatives of aniline is *Rosaniline*, which is quite white until some acid is added. Its acetate, dissolved in water, constitutes the *magenta* dye. Some very splendid and valuable specimens of crystallized acetate of rosaniline, in the form of crowns, are shown at the Exhibition. There is also an aniline yellow, and an aniline blue; but, in general, the shades derived from aniline are those varying from pink to purple. No other dyeing material produces more beautiful or more permanent colours.

The present Exhibition affords abundant proofs of the perfection to which the dyer has brought his art, with the assistance of the chemist. That such valuable and beautiful compounds as the aniline dyes should be produced from so mean a substance as coal-tar, presents the most incontestable evidence of the aid which chemistry may furnish to the arts—an aid the more to be prized when, as in this instance, it consists in utilizing materials which may be obtained in abundance, and which are otherwise of but little value.

TASTE IN ART.

A VISIT to the Great Exhibition at Kensington must have suggested many interesting questions concerning taste in art, and they are not the less important because they are not new. The word art expresses one of the most complex ideas that civilization has evolved, and a perfect theory of art, like a perfect theory of society, is impossible, because analysis must fail to grasp the multiplicity of conditions under which the phenomena are produced. It is probable that certain relations between the structure of the eye and particular arrangements of form and colour, may ultimately enable a physical theory of beauty to be constructed, but this would not help us far on our road. Suppose, for example, that convenience of vision, and the physical comfort of the optical apparatus could be shown to be associated with certain forms and tints presented simultaneously, or in succession, we should still have to consider the more difficult relations of mental and moral association, in order that we might, out of an indefinite number of unobjectionable arrangements, bestow an artistic preference upon those which were best able to express, or stimulate emotion, and thought of an ideal kind. Imagining that we have to deal with an average eye and organization, we must condemn a disposition of colour which is painful, or wearisome, and we must likewise condemn forms, or arrangements of form, that suggest physical discomfort, or which are obviously inappropriate. Upon these principles it is not difficult to come to a wide and general agreement upon many elementary propositions. All people, for example, who are not sufferers from colour-blindness, admire sky-blue, and they can all be brought to disapprove of an inartistic treatment which should give the clear cerulean tint a muddy aspect, by the juxtaposition of a hostile hue. An equal facility for agreement exists with reference to simple harmonies, or discords of colour; but as soon as we approach more complicated problems we find that a prolonged education of the eye is necessary to enable the act of vision to be properly performed. Ask any child the form of objects seen in perspective, and the probability is that you will get an incorrect reply, founded not upon a real attempt to see, and a genuine explanation of what appears to be seen, but based upon wrong notions of the appearance it is supposed they ought to present. A few experiments with a round table, placed edgewise to the observer, and in various slopes, will convince any one how completely seeing is an art which has to be acquired, and show to how slight an extent the acquisition is usually made. If simple objects in easy positions are so little understood by children, or even by numbers of grown-up

people, how much more must defect of vision prevent the appreciation of the beautiful curves that enter into the human form. From outline let us pass to colour, and those who have made no trials will be surprised to find how few persons can see all the tints of an ordinary landscape or street scene. One very noticeable deficiency in uneducated vision is not to see violets and purple-greys, and consequently, to be insensible not only to many of the chief beauties of natural objects, but also to be incapable of appreciating the best efforts of landscape art, The uneducated ear is contented with a few ballad cadences, not even elaborated into anything that can be called an air; the uncultivated eye is equally soon pleased with what is poor and bald, but as the uneducated ear is bewildered and pained by a strain of Beethoven harmony, the uncultivated eye is annoyed by a masterpiece of Turner, or an exquisite picture of Pyne, in which a highly complicated system of colour harmony its introduced.

Art criticisms are so often written by individuals who have not learnt to see, that they meet with little respect in this country. This is a misfortune, as we want methods of judging, and standards of excellence distinct from those which artists themselves set up. The tendency of a painter, for example, is to overrate technical skill and to underrate the human thought which a painting should express. He knows far better than the general public how difficult it is to perform certain manipulations, or imitate special effects. He is also well up in the ordinary rules of his craft, and quick at discerning errors or faults. On the other hand, he may have very low conceptions of the purposes of art. He may be ignorant of history and literature, or he may read the best authors with a dull perception of their meaning; he may look at scenery without the faculty of idealization; the events of life may go on around him; empires may crash, human passion, instinct, and reason may carry on their exciting conflicts, but he may see nothing, feel nothing, to translate into the language of his art. This shows that the mental faculty of seeing requires cultivation as well as the physical, and if criticism were not for the most part a bad penny-a-line sort of business, it would help the artist to create and the public to appreciate a nobler kind of work than we are accustomed to see. Some artists, like Mr. Creswick, establish and maintain a great reputation upon the principle of never seeing in nature more than the average of uncultivated people can understand; others, like Mr. Redgrave, appear to flourish by seeing a trifle less, for out of the thousands who looked upon his "Way through the Woods," in the Royal Academy exhibition of this year, we cannot imagine many to whom a woodland scene would have had so little to say.

XUM

In Eckermann's conversations with Goethe, the following passage occurs:—"Your excellency," said I, "made an excellent remark a little while ago, when you said that the Greeks turned to nature with their own greatness, and I think that we cannot be too deeply penetrated with this maxim." "Yes, my very good friend," said Goethe, "all depends upon this. One must *be* something in order to *do* something." In literature we do not forget this, for, excepting the ephemeral popularity of the trashy school of fast writers, our praise is given to those who *are* more as observers and knowers than ourselves. Artists, however, we treat less rationally, and are apt to over-value their mere technical skill. Rightly considered, this skill is the acquisition of a language in which something great and beautiful should be said, and he who possesses the language, but tells us nothing, is greatly to be condemned. Style in writing, or speaking, is something like the technical part of good painting, and it often covers deficiencies of thought. One who speaks in public with elegance of manner, choice of words, and flowing cadences, is sure to gain applause, even if there is nothing in what he says; except his audience are in earnest, and then the roughest utterance with point and pith in it will be preferred. This earnestness settles art questions as well as those of rhetoric or literature, and it is a maudlin frame of mind that induces people to be contented with a painting, or a sculpture, that leaves them emotionally and intellectually no wiser than they were before. The artist usually depreciates works in which there is a fine thought damaged by bad technical expression, and as we have said before, overrates works destitute of thought, but good in technicality. In this spirit very culpable pictures of Millais have been immensely praised, while his noble conception of Sir Isumbras was frantically abused because the knight bestrided a great rocking-horse fitter for the nursery than the field. The "Black Brunswicker" of this artist was perfection in satin and boots, but the man was as unlike a Black Brunswicker as could be. In fact he looked a creature far more likely to run away than to prove the stern hero determined neither to give nor take quarter, but to move on with iron determination towards inevitable death. Surely, if art is anything more than imitation, it is better to mount a rocking-horse with a great idea, than to make a mistake like this. This year Mr. Millais refutes the theories on which he used to act. He justifies the warmest hopes of those who saw the genius lurking under his most hideous efforts, and after the spectator had refreshed his memory by looking at the Nuns digging their grave at Kensington, and thus seen what could be accomplished by the force of ugliness, he could go to the Royal Academy and observe how the same artist could win higher

triumphs in the "Ransom" and "Trust me," two noble pictures, unsurpassed in power, and violating no sound canons of taste.

Among the foreign pictures which the International Exhibition has brought before British eyes, probably the grandest is that in which M. Gallait depicts the terrible scene of the last honours paid to Counts Egmont and Horn. After recognizing the merits of the less painful and equally fine picture of Egmont's "Last Hours," Mr. Tom Taylor*—in a work which will prove a valuable aid to visitors whose opportunities are brief—thus succinctly describes the more terrible delineation (page 183.)

"Stronger still is the ghastly attractiveness of the next picture, where the bodies of Egmont and Horn, covered by a black velvet pall, and surmounted by their severed heads with the death sweat still damp on the brow and rigid hair, lie in the chapel of the Recollets, for the chiefs of the guilds and civic militia of Brussels to take a last look at those that should have been their leaders. The fact is historical, strange as it may seem. Either Philip hoped the sight would strike terror into the turbulent Low Country burghers, or, confident in his Brabanters and Spaniards, wished to show his contempt of the popular disaffection. In the figures of the guild-masters, M. Gallait has typified the past, in the elderly man, an associate of the headless chiefs in plans and pleasures, who, turns away, terror-stricken and trembling, from the horrid sight; the present, in the stalwart burgher down whose cheeks the tears are falling as he looks at the dead, the hopes of his order, the protectors of the Protestant, the free-handed and gracious Count of Lamoral, the stout captain of Graveling and St. Quentin; the future, in the young archer who exchanges a quick, fierce look of defiance with the Spaniards who stand near the bodies: the one a rough, haughty soldier—the hand of Spain; the other a civilian with polished, cruel face and thin white hand that caresses his dagger-hilt—the head that guides the hand."

This picture is very important in assisting us to arrive at a decision of the principles which should guide an artist in dealing with the repulsive and the ugly. If M. Gallait had invented the scene he would have stood condemned for a gross offence against good taste, in forcing the ghastly spectacle of two guillotined heads upon our view. To be sufficiently true to the nature of the incidents he could not soften down the horrible character of the objects, and thus follow Lessing's direction in "Laokoon," "that the truth of the repulsive in nature should be changed into the beauty of art." Having determined to paint such a subject at all, M. Gallait could only introduce the "beauty of art" as a relief to the

**Handbook of Pictures in the International Exhibition.* By Tom Taylor. Bradbury and Evans.

repulsive facts that would not admit of the transmutation which the German critic required. The cold clammy heads in all the grim horrors of violent death will haunt us with their murderous tale; but the general tone of the picture shows that the mind of the artist lept beyond the scaffold, that he dwelt upon the grandeur of patriotic sacrifice, and saw, in a memorable execution, one of those incentives to heroism through which the liberty of his country was achieved. An Englishman should read Mottley's *History of the Netherlands*, and Newman's *Crimes of the House of Hapsburg* to understand the justification which a Belgian artist would feel in plunging into horrors so profound. We agree with Mr. Taylor in thinking the objections to this picture without reason, but the fact that in this case, the painter needs the justification of history, is sufficient to show how thoroughly the artist should be imbued with Lessing's maxim that "beauty is the highest law of plastic art."

There is another important picture open to adverse criticism upon a widely different ground. It is the "Roman Martyr" of Delaroche, which appears to divide the attention of the public with the far greater picture of "Marie-Antoinette going to the guillotine." In the last work, art criticism finds itself disarmed, although the Marie-Antoinette of the painter possesses grand attributes which certainly did not belong to the poor victim of that volcanic time, when the wrongs of centuries fairly boiled over in an excited and outraged land. In discussing the "Roman Martyr," we cannot do better than again have recourse to Mr. Taylor. It is the representation of "a maiden victim of the persecution of Diocletian, whose virgin body, floating in the Tiber, is revealed to those who seek it for interment by the aureole miraculously suspended above the pale face that looks serenely up to heaven from the green water." It is to the aureole that we object, on the ground that a physical miracle of this kind is not a legitimate subject for pictorial art. The general tone of the picture is real and natural; and this bit of supernatural, not conforming with the laws of the distribution of light, is an eyesore that mars the scene. It is a pretty legend that supernal powers hung their aureole over the dead Christian girl. A line of Tennyson would have made its light live for ever, but the paint brush should have been kept away—it is too gross a tool.

The selection of subjects is as important as their treatment, and we cannot excuse an artist in portraying horrors, because our disgust is mainly directed against those by whom they were committed. We acquit Gallait on the ground we have mentioned, but we condemn Gerôme for torturing our eyes with the brutalities of the Roman circus. If he had lived at the time

when such a picture would have been the protest of reformers against the coarse cruelty of imperial savagery, he would have had his justification upon moral grounds; but why rake up disgusting materials, which time has benevolently buried? Better surely to see the beauty of the present, than the ugliness of the past.

In our own country the appreciation of the beautiful in art has wonderfully progressed within the last ten years, and although we should like to see public bodies sufficiently intelligent to create a demand for high class works adapted to galleries and halls, we rejoice at the domestic character which our best pictures assume. As a rule our artists endeavour to produce paintings calculated to adorn a home, and if in this effort the majority tend towards conventionality, tameness, and commonplace, occasionally varied by slap-dash violence, the fault lies more with society than with themselves. Few people will take the trouble to understand anything that requires study, and the same mental indolence which prevents thousands from mastering the elements of science, condemns them to perpetual childhood in respect to literature and art.

What direction French popular taste will take as the progress of industry enlarges the class of private buyers, may be somewhat difficult to tell, but there are evidences of a growing fondness for scenes of domestic and humble life. The battle pieces which their artists delineate with a skill that no others attain, are not natural results of national demand. Successive governments have seen their interest in demoralizing the people by an everlasting parade of the circumstances of war. In this way they have successfully touched a chord of national weakness, which we, who take the victories we are obliged to win, with Quaker-like quietness, can scarcely understand; but pictures like those of Edouard Frère and Henriette Brown show that our neighbours can see and enjoy aspects of life better worth contemplating than deeds of arms. As the people grow in intellectual and social importance their domestic incidents have more value in their own eyes; and though we laud the Belgians for their historical recollections, we praise the Norwegians still more for the thoroughly human and humanizing efforts in which Tidemand's pencil is engaged. Peasant life as shown in his pictures is a great thing in its way. It struggles with poverty, but is not ground down. It has its variety of thought and emotion—manly individuality, if not much female grace. Above all it has, for Englishmen, the attractions of foreign travel. You forget all about London, and seem inside the Norwegian hut. The pastor may be too tough and stolid to enter much into the grief of the receipients of the holy rites which he mechanically administers; we might like a greater charm of colour, or brilliancy

of light, but Tidemand has successfully carried us with him and made us listen to his tale. We have as yet no such painter to deal in a spirit of equal earnestness with the phases of our village life. We are tired of the same children at the same school, with the same light streaming through the same casement, and falling upon the same deal boards; quite sick of peasant girls carrying pitchers, or gleaning, and polished up to the same degree of drawing-room correctness; and we want some one who can discover that working people are men and women, with hopes, fears, loves, hatreds, and aspirations, just like the more fortunate inhabitants of fashionable clothes. Historical pictures will not be much wanted now that society finds its good and evil determined, more by a multiplicity of unknown individual exertions, than by startling events; the classical gods and goddesses are used up, we have outgrown angels that look like celestial poultry, and would not be sorry if Mr. Frost's nymphs should be bound in perpetual ice. We want realities of to-day —not the less real because contemplated in their ideal aspect, and if we get them we care not from whence they come—whether Mr. Goodall brings us a stately pilgrim from sunburnt Egypt, or Mr. Millais finds his romance in the breakfast-room of a country squire. Let our artists, however, pay some attention to the meaning of what they are about. It is melancholy to find a big canvas by Mr. Ansdell pretending to illustrate Longfellow's "Excelsior." In that poem he ought to have known that the scenery is accessory and quite subsidiary to the moral which the author intended to convey. The "banner with the strange device," the mountain height, the struggling youth, and the voice which "fell like a falling star," are all in keeping in the magic verse, but Mr. Ansdell strives to give us a *caput mortuum* which does not make us care for the defunct traveller, and suggests no memories of Longfellow's rhyme. Another artist, Mr. Solomon, with far more cleverness, tells us in his motto exactly what he is *not* about. To illustrate the sentiment of the text, "Thou hast turned for me my mourning into dancing; thou hast put off my sackcloth and girded me with gladness," he depicts a family startled by the return of a member supposed to be no more. The mother, instead of "dancing" is likely to faint, the sisters, instead of being "girded with gladness," are scared out of their wits. A still worse offender in misunderstanding words, is Mr. Witherby, who takes the last verse of Tennyson's poem, commencing—

> "Break, break, break
> On my cold grey stones, oh sea,"

as the motto of a picture in which certain crags are made uncommonly hot in a sunset's reddening blaze. Our poets supply

abundant themes; but unless they can supply the intelligence necessary to understand them, every new book they publish seems likely to lead the artist astray.

Our first-class landscape art is, on the whole, very good, but we have few painters who seem to have any appreciation of the variety of nature, and when a particular scene like Tintagel Castle is done into oil and water, many times a year, it is wearisome to find nobody entering into the spirit of the place, or able to discern the magic web of changing colour which, under favourable circumstances, the Cornish coast presents.

In painting we are escaping from the conventional system of the last generation. Dirty brown "old masters," as all smoky bits of canvas used to be called, no longer exert a despotic sway. Our artists are free to use their five senses, and what thinking faculty they possess. Painting is emancipated, and we may anticipate its advance. Sculpture is deeply indebted to Mr. Gibson for his tinted Venus, which, whatever may be its merits, is a contribution towards liberty in another field of art. The tinted statue question is too big to come in at the end of an article, but it is plain that the discussion which Mr. Gibson has provoked must assist in removing a mass of mere prejudice and cant. In other departments we want an emancipation movement too. Why, for example, should Minton's pottery halt between old notions and new? If some skilful maker of pots and platters in the middle ages did things that were ugly, as well as things that were fine, why must we suffer a descent of bad taste. It is because we admire Mr. Minton's ware that we care to point out its defects. We want to know why its grotesque should be ugly, when Cellini and the mediæval church builders have shown that the grotesque and the beautiful may be combined. Why should so much technical skill as this justly famous house has brought to bear upon its work be sometimes degraded into constructing great clumsy vases supported by miserable naked babies, with hydrocephalous heads, and distorted bodies, tied to their burdensome task with fetters of silk? We do not want monstrosities which require a Geoffroy St. Hilaire to elucidate, but demand from artists of all kinds that they shall exhibit to us "Beauty" as Akenside depicted her, "the lovely ministress of Truth and Good."

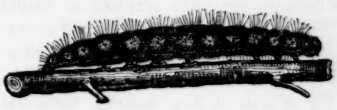
POISONOUS CATERPILLARS.

BY H. NOEL HUMPHREYS.

THE caterpillars of several species of Moths, and also of Butterflies are provided with means of defence which are more or less venomous; but we seldom hear of fatal consequences arising from their venom, though many of the poisonous species are natives of Europe. This season, however, a boy, injured by the noxious hairs of the procession caterpillar subsequently died; and several persons in Belgium, have suffered serious illness in consequence of eating cherries gathered from trees infested by a caterpillar, the name of which is not given in the notice which furnished me with the information. Several kinds of our native caterpillars have the defensive power of emitting a fluid which produces considerable irritation of the skin; and in others, the hairs, when touched, produce an effect somewhat analogous to the sting of the nettle. Some children in my neighbourhood, attracted by the gay colours of the little caterpillar of the Gold-tailed Moth, endeavoured to rear a brood of them, in order to obtain fine specimens of the elegant White Moth. During the whole time (some weeks) that they were so engaged, the backs of their hands, and their faces also, were covered with red patches, which fortunately gave but little pain till rubbed or otherwise irritated. When the caterpillars went into the chrysalis stage, the red patches on the hands and faces of the young entomologists disappeared; but on obtaining some more caterpillars of the same kind, they again made their appearance. An experienced naturalist informs me that he once suffered a very sharp feverish attack while rearing a brood of these caterpillars; that the skin of the hands and face became painfully inflamed; that he suffered intense thirst, and was confined to his room for several days. The caterpillar of our largest and handsomest native butterfly, Papilio Machaon, popularly known as the Great Swallow-tail, is furnished with a fork-like tentacle on the neck, of a red colour, from which it is enabled to emit a strongly-scented fluid which is said to drive off its most dangerous enemies, the ichneumon flies; and when coming in contact with the human skin it produces an unpleasant though slight irritation. The small larva of Dicranura Vinula has a similar excrescence near the head, both points of which are furnished with many perforations, like the rose of a watering-pan, through which it can eject to some considerable distance a tiny shower of acrid fluid, which, if it fall in the eye, produces acute pain, and the effects are sometimes permanently injurious.

The injuries sustained from contact with the hairs of the procession caterpillar are, however, much more serious than those resulting from the more slightly venomous character of any of our native species; indeed they sometimes prove fatal, as before stated. As this caterpillar is very remarkable in other respects, I propose to give a short account of its general characteristics. It is in some years so numerous in many parts of France, that its devastations in the orchards, and even among forest trees, assume an alarming character; entire trees being so completely stripped of their leaves that they inevitably perish. In 1732, their ravages in the south-west of France were so extensive that the Parliament of Bordeaux issued an edict compelling the rustic population to clear the trees of caterpillars, under pain of severe penalties. There have been local enactments of similar character in England, but this is not the place to speak of them.

The Cnethocampa processionea,* or procession caterpillar, is in some seasons but too plentiful in many parts of France, as will have been perceived by my previous remarks, but the Forest of Bondy, and the Bois de Boulogne, near Paris, are mentioned by entomological collectors as places where it is found in most seasons. The caterpillar is about one inch and a half in length, and is grayish black, with tufts of brownish gray hairs. The engraving below will give a tolerable idea of its general appearance, even without the aid of colour.



The caterpillars of Cnethocampa processionea do not scatter almost as soon as they are hatched, as is common with most species, each individual seeking its food alone, but the whole brood remains together, as in some other gregarious kinds. Some of the gregarious caterpillars alluded to live in a large web, common to the whole brood; but each procession caterpillar, though living in society with the entire brood, weaves itself a more or less separate nest. These nests, generally attached to the trunks of trees, are made in compartments, but have only one general entrance. The mode in which the caterpillars go out to feed, following each other in a single line, is the peculiarity on which their name, procession caterpillar, is founded. Towards dusk, or when the sun is not shining

* This genus was included by Reaumur and his contemporary entomologists in the great division, Bombyx, which has been subdivided by more recent naturalists. The present distinctive generic title, Cnethocampa, is derived from the Greek word, κνηθω, to irritate, and καμπη, a caterpillar. The derivation of the specific name is obvious.

(says Reaumur, whose observations, in the last century, may be said to have laid the foundation of modern entomology), a single caterpillar goes out first, and, after some hesitation, appears to determine the line of route that is to be followed by the colony. He is succeeded by a second—a third then appears, and so on, till the whole colony is following the leader in single file; the line being sometimes thirty or forty feet long. As the food becomes exhausted in the neighbourhood of their nest, they select another centre for their foraging excursions, and establish another set of nests upon the trunk of some fresh tree well suited to their purpose. These nests are slight, but the nest, or rather cocoon, which they construct for the purpose of retiring to when about to enter the dormant state in which the change to the chrysalis, and then to the moth, takes place, is much more compact. The cocoons, being placed close together, slightly resemble in appearance the cells of humble-bees.

Each caterpillar seals up the opening to his cocoon, or cell, with his own hair, a portion of which loosens and falls off at this period of his existence. These chrysalis-houses are more dangerous to touch than the caterpillars themselves, for when the external web is broken or removed, the disturbed hairs at the opening of each cell are carried about by the slightest wind, and whenever they settle on the skin, a kind of irritation commences very similar to that caused by the sting of a nettle. The boy who recently died from this cause had been climbing a high tree in search of a bird's nest, and no doubt his chest had come in direct contact with a set of cocoons of this kind, for it was in the hands, face, and chest, especially the latter, that the chief seat of irritation, that could not be allayed, had established itself.

These poisonous hairs, however, which are so injurious to the human skin, do not appear (in spite of all that has been said upon the subject of their being a defence provided against their natural enemies) to be injurious to the birds that prey upon them, as the bodies of these caterpillars have been found in the stomachs of birds that have been shot, without seeming to have caused any internal injury, the stomach of the bird remaining in a healthy state. One of the handsomest of our European beetles, Calosoma Sycophanta, feeds upon the caterpillars of the pine-species, C. Pityocampa, following them among the branches of the pine, where it destroys vast numbers of them.

There are also caterpillars that feed upon them; these carnivorous caterpillars being termed by the French *vers assassins*. The procession caterpillar does not attempt to escape from his unnatural brother, but submits passively to his fate—fascinated, perhaps, in some way, like the bird that becomes paralyzed

under the fixed gaze of certain snakes; or, like the antelope, who remains motionless when the roar of the lion has announced his fatal spring.* It need scarcely be added that the caterpillars that prey upon the processionists do not appear to sustain the slightest inconvenience from the poisonous hairs. But I must return to the immediate history of the procession caterpillar himself: he enters the chrysalis state about the middle of July, and the moth appears in August, when it lives but a few days, the female dying immediately after the deposition of her eggs. The hairs on the body of the perfect insect or moth are nearly as venomous as those of the caterpillar. The colour of the moth is gray,

with brown transverse stripes, which are sometimes indistinct. There is another species of this genus, Cnethocampe Pityocampa, which feeds almost exclusively upon the pine. The moth is very similar in appearance to C. processionea, being only distinguished by having three dark transverse stripes on the wings instead of two. Feeding on evergreens, the caterpillars of this species do not require and are not dependant upon the fresh foliage of the spring and summer. They are hatched about the middle of September, and as the cold weather approaches before they are full grown, they make a tolerably substantial nest in which to pass the winter in a dormant state. They awake from their hybernating sleep about the 31st of March. Sometimes they remain outside the nest a whole day or more before they venture forth in search of food, which, says Reaumur, "they must be in great want of after their six months of fasting." In fine weather they congregate on the outside of their winter nest on their return from feeding excursions, but bad weather drives them for shelter to its interior. The web, or silk, of which this nest is composed, was sent to Reaumur, in order that he might test its fitness to supersede the product of the silkworm. Experiments were tried, and seemingly with complete success, pretty-looking articles being woven from it, but they were found to have the inconvenient property of completely dissolving in hot water. Having attained their full growth, the caterpillars do not, like the allied species, form a series of adjoining cocoons, but bury themselves in the ground, to undergo separately their transformation to the chrysalis state. The habit of forming a single

* Dr. Livingstone, who was seized by a lion, declares that the terrible roar which accompanied the spring seemed to deprive him of all sense of pain, though his arm was dreadfully torn.

line of procession when they go forth in search of food is the same in this species as in the other, every sinuosity of route taken by the leader being followed by each caterpillar in the line, both in going forth and in returning.

The mass of absurd stories connected with these caterpillars, which Reaumur has curiously preserved, in the letters of his correspondents, appears now almost incredible. For instance, it was asserted, among other things, that they never arrived at a winged state, but laid eggs while in the caterpillar state ! ! Another absurd conviction of the uninstructed observers of that day was, that these caterpillars were the offspring of spiders, this extraordinary idea having arisen in consequence of spiders having been found in the nests. It is indeed now a well known fact that spiders frequently take possession of the deserted nests of the winter procession caterpillar, and this was sufficient to give rise to an assertion, which in those days was not put to the searching tests which such a statement would now have to undergo before being admitted among the facts of natural history, but was allowed to pass current, for the delight of wonder-mongers, an amiable race not yet entirely extinct. This ridiculous theory concerning the maternity of the procession caterpillar is to be found categorically stated, at considerable length, in the *Journal de Verdun*, for March 1734, page 165.

NEW PROCESS OF VINEGAR MAKING.

THE following important paper, by M. Pasteur,* has recently been read before the French Academy, and it will be found to present many points of industrial and scientific interest.

"I had the honour of bringing before the Academy in the month of February, the property possessed by mycoderms, especially those of wine and vinegar, of acting as agents for conveying the oxygen of the air to a crowd of organic substances, and thus lead to their combustion with a rapidity that is often surprising. The study of this property of mycoderms has led to a new method of manufacturing vinegar, which seems destined to practical application in this branch of industry. I sow the *mycoderma aceti*, or *fleur du vinaigre*, on the surface of a liquid formed of ordinary water containing two per cent. of its volume of alcohol, and one per cent. of acetic acid resulting from a previous operation. In addition to this, I add some ten thousandths of alkaline and earthy phosphates. The plant develops itself, and soon covers the entire surface of

* *Comptes Rendus*, 7th July, 1862, p. 28.

the liquid, not leaving a vacant spot. During this time the alcohol is acidified. While the operation is in full progress—when, for example, half the original alcohol is transformed into acetic acid—alcohol, or wine, or strong beer is added, day by day, in small quantities, and the process continued until the liquid is found to contain enough vinegar for commercial use. While the plant is able to excite acetification we add alcohol; and when its action begins to be exhausted, we leave it to complete the acetification of the alcohol still remaining in the liquid. The plant is then separated from the fluid, and on washing, it yields a slighly acid and azotized liquid, capable of ulterior use.

"The fermenting tub is then put to fresh work. It is indispensable not to suffer the plant to want alcohol, because in that case its oxygen-transporting faculty would exert itself partly on the vinegar, which it would transform into water and carbonic acid, and partly on those little understood volatile principles, the loss of which renders the vinegar flat and destitute of aroma. Moreover, if the plant is once turned away from its vinegar-making action, it will only employ it again with diminished energy. Another precaution, not less necessary, is not to excite too great a development of the plant, for its activity is then exalted without measure, and the acetic acid will be partially changed into carbonic acid and water, even while alcohol still remains in the liquid. A vessel of one square metre (about thirty-nine inches) surface, holding fifty to a hundred *litres* (say from ten to twenty gallons), will yield acetic acid equal to five or six *litres* of vinegar a day."

M. Pasteur recommends shallow wooden vessels, like the coolers used in brewing, to be employed in this process. They should be furnished with covers, with two small openings for the entrance of air. Two tubes of gutta-percha fixed to the bottom of the vessel, and pierced laterally with small holes, readily permit the introduction of fresh supplies of alcohol without disturbing the fungus film that forms on the surface. The presence of phosphates is necessary, as they furnish the mineral food of the plant, and if phosphate of ammonia be among them, the plant takes from its base the nitrogen it requires, so that complete acetification can be carried on in liquid containing a ten thousandth part of the phosphates of ammonia, potash, or magnesia.

Commenting on the advantages of this method, M. Pasteur states that two processes of vinegar making are now employed in France. One of these, called the Orleans process, is only applicable to wine. It is carried on in casks ranged horizontally, containing inferior *vin ordinaire,* and one-tenth of its bulk of vinegar. After about two months each cask begins to yield vinegar at the rate of about ten *litres* a week. In the

second, or German method, the liquid to be acetified is allowed to trickle over shavings of beech wood contained in large barrels to which the air has access. This plan is rapid, but not applicable to wine, nor to beer in its natural state, and its product is of inferior quality, especially when derived from alcohols with a bad flavour. The wine-vinegar of Orleans in part owes its fine qualities to the presence of aromatic substances, which are carried off by the high temperature and the strong current of air which are permitted in the German method. There is, however, a singular inconvenience in the Orleans mode, which gives rise to myriads of the so-called vinegar eels.* These little creatures require air in order to live, and the film of the vinegar plant tends to deprive them of it. M. Pasteur says,—"My experiments have shown that acetification only takes place at the surface of the liquid in the thin film of mycoderma aceti that is incessantly renewed. Suppose this pellicle well formed, and the work of acetification actively proceeding, all the oxygen that arrives at the surface of the liquid is employed by the plant, and none is left for the eels. The latter finding themselves deprived of the possibility of respiration, and guided by one of those marvellous instincts of which all animals, in different degrees, offer us such singular examples, take refuge on the sides of the casks, where they form a thick white crawling mass." From this position they carry on war with the vinegar plants, often getting the upper hand, and forcing the latter downwards below the surface of the fluid, and thus more or less completely arresting the fermentation. In M. Pasteur's process the eels are not admitted, and as the acetification takes place at a low temperature, the aromatic elements are not destroyed. We believe the "Fleur du Vinaigre," or "Mother of Vinegar," although not presenting the same external appearance, is substantially identical with the solid leathery fungus that, under the name of the "Vinegar Plant," is often used by English families to induce the acetic fermentation in solutions of treacle and sugar.

* Anguillula aceti.

OPPOSITION OF MARS.—DOUBLE STARS.—OCCULTATIONS.—THE COMET.

BY THE REV. T. W. WEBB, F.R.A.S.

OPPOSITION OF MARS.

A PLANET revolving round the sun in an orbit exterior to our own, and therefore, by the 3rd law of Kepler, with inferior speed, must necessarily be overtaken and passed by us from time to time, and these epochs will be attended with remarkable changes in the planet's apparent movements. So long as our own motion is such in point of direction and swiftness as not to give a false impression of the progress of the exterior planet, it will of course be seen to move, as we and all other planets really move, from W. to E., according to the order of the signs of the zodiac, or, in astronomical language, *direct;* but as soon as our position and velocity become such as to make appearances prevail over realities, our neighbour will first seem to slacken his speed, then to stand still, and ultimately, while we are in the act of passing him, to move backwards, or, astronomically speaking, to *retrograde;* as we leave him behind his reversed velocity will gradually decrease, till he again become stationary, to recover himself as it were, and afterwards starts afresh, and proceeds quietly on his own way. These phenomena are, of course, the same with those which may be noticed when a train passes an ordinary vehicle, or a steamer overtakes a sailing vessel. The precise position in which our neighbour is passed by us is called his *opposition*, because he is at that time exactly opposite to the Sun, and comes to the meridian at midnight; and being then, of course, at his least distance from us, this will be the most favourable opportunity for the study of his physical peculiarities under an enlarged diameter. Such is about to be the case with the planet Mars, whom our readers must have been for some time noticing as the most conspicuous as well as the most ruddy object in the Eastern sky. He becomes stationary on September 2, and from that time will rapidly increase in brilliancy as we are coming up to him, till, on October 5, we shall pass him by; after which date he will fall off in appearance and speed till, on November 7, he reaches the end of his retrogradation, becomes stationary, and subsequently proceeds in the ordinary direction till we begin to come round after him again, not, however, to overtake him till after two years and fifty days. Such is the general principle and aspect of these optical changes: but they are not invariable in their amount. They would be so, if the planetary orbits were of a circular form; but since they are elliptical, and the ellipses have no fixed position in space, but are subject to a continual vari-

ation in the direction of their longer axes, every succeeding opposition will take place under fresh relations, oscillating between the most favourable circumstances, when the Earth is in its *aphelion* or furthest from the Sun, and the planet nearest, in its *perihelion*, and the least favourable, in the reverse of these conditions. With regard to Mars, the difference is very considerable. His orbit is so elliptical, that when furthest he is distant from the Sun 158,754,000 miles, when nearest, only 131,656,000; so that his best opposition, so to speak, brings him more than 27,000,000 of miles nearer to us than his worst, from the form of his own orbit; while the excentricity of ours may increase or diminish this quantity by nearly 3,250,000 more. His apparent diameter of course varies in a corresponding proportion from little more than 13″ to upwards of 30″: at the coming epoch it will amount to 21″·8. The greatest expansion of disc will, in consequence of the mutual obliquity of the two orbits, take place on September 29; but the difference for a considerable time will not be material, as it will range above 20″ from September 5 till October 20; at the first of which dates there will be a slight phasis or defalcation from the perfect circle on the W., as at the latter on the E. limb. Had the opposition taken place between the aphelion of the Earth on July 1, and the perihelion of Mars on August 4, it would have been still more auspicious, and had those epochs coincided, as they nearly did in August 1719, the planet would have assumed unwonted magnitude and splendour; but the present is by no means an unfavourable opportunity, being little inferior to the opposition of 1830, which Beer and Madler found so advantageous for the delineation of his physical aspect. In another respect too it will be suitable for the observers of Europe, as the planet is a little N. of the equator; on some other occasions it has had such wide S. declination when we passed it as to be fairly visible only in equatorial or southern latitudes: in such a position, the most powerful telescope in our northern observatories would show it far less satisfactorily than a much smaller one upon the coming occasion. Such of our readers as are possessed of instruments of moderate capability will therefore prepare themselves for the examination of that fine ruddy disc, which, in its appearance of continents, and seas, and snowy poles, and atmospheric obscurations, as well as in its diurnal rotation and its change of seasons, presents so great and interesting a resemblance to our own globe. On these points a few remarks will be offered in a future paper.

P.S. August 15. A brief interruption last night in our wonderfully persistent cloudy veil exhibited the S. polar snows very distinctly, though of no great extent. There was much dark mottling on the disc, but no decided spot.

DOUBLE STARS.

We must now view the jewels in the hand of *Boötes*, which he has been lifting up for so many centuries above the end of the Great Bear's tail.

A little way *n f* from *η*, *Al Kâid* or *Benetnasch*, the last star of the tail, lie three small stars in a triangle, *θ*, *ι*, and *κ Boötis*, of which the two next *Al Kâid* are nearest together. These are *ι*, S, and *κ*, N. Each will repay the search.

31. *ι Boötis*. 37″·9. 33°·4. $4\frac{1}{2}$ and 8. Light yellow and dusky white, 1850·6. I thought the *comes* lilac about the same time. Sestini made it azure, 1844·5. This pretty object, which Struve thinks has a common proper motion, is rendered more interesting by the fact that the Czar's great telescope at Poulkowa, of $14\frac{3}{4}$ inches aperture, shows that the larger star is very closely double, consisting of two equal components, with a distance of only about 0″·3; so that we probably have a wonderful triple system here. Smyth, as might be expected from his inferior optical means, could only detect a slight elongation. A more beautiful object, however, is its neighbour—

32. *κ Boötis*. 12″·7. 238°·1. $5\frac{1}{2}$ and 8. Pale white and bluish. No satisfactory evidence of movement.

If we now carry a line from *Alioth*, *ε Ursæ Majoris* (the 5th star in succession, beginning with the Pointers), through our old friend *Mizar* (No. 1), and pass it on through the before-mentioned triangle forming the hand of Boötes, when it has reached nearly as far again as the distance from *Mizar* to the hand, it will fall upon a little close group, of which the brightest is—

33. 44 *Boötis*. 2″·9. 233°·8 (1830·82). 4″·1. 236°·2 (1847·45). 5 and 6. There has been much difference of opinion as to the colours. Smyth made them pale white and lucid grey, 1842·58; yellow and cerulean blue, 1850·5; pale yellow and dusky, 1856, which, he observes, agrees nearly with Struve's *subflava* and *subcœrulea* (1832·24). On the other hand, Sestini called them both orange, 1844·5; Fletcher, white and yellow, 1851; Miller, both white, 1853; Dembowski, yellow and ruddy orange or olive yellow, 1854, 1855; pale yellow and pale orange, 1856. I thought them yellow and ruddy or purplish, 1850·63, with an aperture of $3\frac{7}{10}$ inches. I regret to add that the almost unbroken veil of cloud which has obscured our summer skies, has, up to the present time, precluded me from re-examining this, and other similar objects, with my present much more powerful telescope. In another respect this is a very interesting pair, as there can be no doubt of its binary character, though as Smyth remarks, the case of its orbital motion is "beset with difficulties." It was so close in 1781 that it was recommended by Sir W. Herschel, together with 52

and 33 Orionis, neither exceeding 2″ in distance, as a test for a superior instrument; its movement during the present century has been such as to indicate, in Struve's opinion, a *sidereal occultation* between 1802 and 1819, when its distance was 1″·5, with the smaller star on the other side. The same observer thought it was approaching its greatest distance in 1835, when it measured 3″·17; but Secchi found it 4″·738, 1859·515. The ellipse in which it is moving is probably foreshortened almost into a straight line. Secchi, between 1855 and 1859, thought the brightness reversed, so that there may be a variation of light, which was also the opinionof Struve and Argelander.

Retracing our path a little from this object towards the hand of Boötes, but keeping somewhat below our guiding line, we find a very minute star, which the telescope expands into a beautiful pair—

34. 39 *Boötis*. 3″·8. 44°·7. 5½ and 6½. White and lilac. Some observers ascribe a bluish, some a ruddy tint, to the small star. Struve considered them to be probably moving, but Smyth and Secchi doubt this. I thought in 1850 that the difference in magnitude was less than that assigned by Smyth in 1839. Secchi gave them 6 and 6·5 in 1856; 6 and 6·2, 1857: perhaps there may be variable light here.

We now proceed to *Corona Borealis*, the *Northern Crown*, a beautiful little constellation, the principal part of which is well marked out by an ellipse of 4 and 6 mag. stars, among which is one of 2 mag. (*a*), lying in a line between *Arcturus* and δ *Herculis* (No. 25). A line drawn from *Arcturus* through ε (No. 19) and δ (No. 23) *Boötis*, bent a little to the left, will fall upon—

35. ζ *Coronæ*. 6″·1. 301°·2. 5 and 6. Flushed white and bluish green. This truly fine pair, notwithstanding its aspect, is very satisfactorily shown to be stationary, as far as our present evidence extends.

Our next object is found by a more complicated process. We draw a line from *Wega* to *a Coronæ*: this passes, at about three-fifths of the distance, a little above ζ *Herculis*, 3 mag., the brightest star in the vicinity. Another line from ζ *Herculis* to ζ *Coronæ* (our last object), at about one-fourth of the distance, falls upon—

36. ν^1 and ν^2 *Coronæ*, a noble 5 mag. pair of yellow stars, rather more than 6′ apart, to each of which an aperture of 5½ inches shows a minute attendant. A low power includes another star of about 6 mag., forming a splendid field. A little way (2°) *p* lies—

37. σ *Coronæ*. 1″·3. 107°·6 (1830·76). 2″·2. 176°·8 (1852·25). 6 and 6½. Creamy-white and smalt-blue. There is much discrepancy about the smaller star. South calls it "certainly not blue," and differing very little from the other, 1825; Struve, white, 1836·69; Dembowski, yellow, ashy, and doubtful blue, 1854 to 1857; Secchi, sometimes blue, sometimes

yellow, 1855 to 1857. I fancied it, with a $3\frac{7}{10}$ inch object-glass, at one time ruddy, at another bluish, from 1850 to 1855, apparently changing even while being looked at; a versatility of hue which I have remarked in other stars similarly circumstanced, and which may possibly depend upon unequal sensitiveness to colour in different conditions of the retina; during a short glimpse with $5\frac{1}{2}$ inches, 1862·57, the companion seemed bluish; at the same time I thought, as I had done in former years, that there was more than $\frac{1}{2}$ mag. of difference. Struve gave more than 1 mag. Secchi's discordances are considerable, ranging between $\frac{1}{2}$ and 2 mags. from 1855 to 1857; but the honesty of that excellent observer, in recording every temporary impression, must be allowed for. The binary character of this double star, sufficiently evident from the foregoing data, which indicated to Smyth a period of not less than 560 years, has been further confirmed by its continued movement, Secchi having found 2″·478 and 184°·77, 1857·711. The period, however, remains a puzzle. Hind has given 737 years; Eyre Powell, 240; Jacob, 195. "This is certainly," as the Admiral remarks in professional language, "more yawing than might have been looked for;" and we might still add Mädler's 608, and Klinkerfues' 420 years. This beautiful pair is converted into a triple group by the addition, in a far-reaching perspective, of a blue 11 mag. star, called 15 or 20 mag.* by South in 1825, and not perceptible to him with a power of more than 92 upon 5 inches of aperture, so that it may possibly be variable. The increase of its distance from 44″ in 1839, to upwards of 49″, according to Secchi and Mädler, in 1855, gives ocular proof of the proper motion of the other two, while its fixed position serves instead of a micrometer, to make their rotation sensible. In 1839 the angle between the directions of the two smaller stars was about 56°; a glance at their present position will show that it rather exceeds 90°. In this very interesting and unusual instance, angular progress is rendered distinctly perceptible to amateurs unprovided with the means of measurement, and much more satisfactorily so than by mere comparative estimates from the direction of motion through the field.

38. *η Coronæ.* 0″·8. 57°·2 (1832·63). 0″·5. 246°·8 (1852·43). White and golden-yellow. The period is stated by Smyth at about 44 years. Yvon Villarceau prefers 67, but Winnecke finds the observations best represented by 43. What a glorious idea is given to every thoughtful mind of the power of the Creator, and of the infinite variety of his creation, by this rapid revolution of these two magnificent suns! The object

* It must however be borne in mind that this observer calls the attendant of Aldebaran 20 mag., which Smyth rates 12, and which Dawes has seen with only $2\frac{3}{4}$ inches of aperture.

is perhaps somewhat difficult for a list like the present, but since it may now be seen elongated with a good $3\frac{3}{4}$ inch object-glass, and is beautifully divided with my $5\frac{1}{2}$ inches, it seems better not to omit so celebrated a test. Sir W. Herschel considered it, in 1781, as the most difficult but one of all his double stars; in 1832 Smyth could see a black division, but nothing more than an elongation, never even notched, from 1839 to 1852. Secchi could only doubtfully divide it with the splendid Roman achromatic in 1855; in 1859 this was my own case with a power of 460; but in 1860, when Dawes measured it at 0″·87, I succeeded in dividing it, and it is still widening, as I found it, on June 3 last, well separated with 275. There is little difficulty in finding it. A line from *α Coronæ* (see No. 35) to δ *Boötis* (No. 23), passes first through *β Coronæ*, 4 mag., and then, a little further on, falls upon *η*. The beginner will find it an excellent method to prepare the focus of the telescope by adjusting it as carefully as possible previously upon some of the closer pairs in the neighbourhood, as given in the foregoing list.

We now return to *Hercules*, where a line from *a* through δ (No. 25) carried more than as far again, points out *π*, 3 mag., the brightest of its vicinity, remarkable for its very fine deep yellow hue; immediately *f*, are two 4 mag. stars, the furthest of which, in a line towards *Wega*, is

39. *ρ Herculis*. 3‴·7. 308°·9. 4 and $5\frac{1}{2}$. Bluish-white and pale emerald. This beautiful pair seems to be only optical. Smyth found it within the range of two inches of aperture.

λ *Herculis*, a single 4 mag. star, a little *nf* δ, is worth looking at for its colour, a deep, dull orange, with my old $3\frac{7}{10}$ inches, but which I now see somewhat like that of Antares, yellow encompassed by a scarlet glare. It is towards this part of the heavens, according to Sir W. Herschel and Argelander, that our Sun, with his whole attendant system, is being carried by "proper motion" through space.

40. 95 *Herculis*. 6″·1. 261°·8. $5\frac{1}{2}$ and 6. Light apple-green and cherry-red: a beautiful and curious instance of difference in colour between stars of very nearly equal magnitude. Secchi thinks the red the larger, the green the brighter of the two. Notwithstanding the complementary character of the tints, which might be thought to infer a connection, no motion has yet been detected. To find this charming object, we must have recourse to a fresh *pointer*, *Al Tair*, the *lucida* of the constellation *Aquila*, which we shall at once recognize as the brightest star in the S.E. heavens, standing just E. of the left-hand branch of the galaxy, between two 3 mag. attendants *γ n p* and *β s f*. A line from δ *Herculis* to *Al Tair* will pass, at a little more than one-fourth of its length, through a group of 5th mag. stars, of which the nearest to δ is our object.

If we look *s* from *a Ophiuchi*, a little *f*, we shall come upon *β Ophiuchi*, 3 mag., the brightest of its neighbourhood, lying from *a* as far again as the distance between the "two heads." *β* has *γ*, 4 mag., a little way *s f*, and *γ* is followed by a vertical line of three small stars, with a fourth nearly following the central one, but somewhat to the *s*. The central one of these three is—

41. 67 *Ophiuchi*. 54″·7. 143°·6. 4 and 8. Straw colour and purple. Wide, but a pleasing contrast in size and colour, in a fine field of minute stars.

The fourth star, nearly following the central one, is—

42. 70 *Ophiuchi* (often designated "*p*"). 5″·43. 136°·4 (1830·76). 6″·8. 119°·7 (1847·48). 4½ and 7. Topaz yellow and purplish. This is one of the most celebrated binary systems, and great trouble has been taken with it by many of the first observers. Mädler fancied its movements could not be reconciled with the law of gravity. Struve found that his Dorpat telescope gave smaller measures than his former ones, or than those of Sir J. Herschel, South, and Dawes. Jacob, after paying much attention to this object, is still dissatisfied, and suspects disturbance from a third invisible companion. Secchi, again, refers such discrepancies to errors of observation. In fact, where the quantities to be ascertained are so extremely minute, it is evident that there must be unavoidable differences arising not only from the imperfection of instruments, but from the diversity of eyes and judgments. The latter source of disagreement, known among astronomers by the term "personal equation," has a wide range of influence, and has been made the subject of considerable inquiry; since with the same micrometer some astronomers are known to measure distances very differently from others; and the judgment of the same eye seems liable to change; and all this requires to be allowed for in comparisons. But in such hair-splitting processes the general agreement which will be found to obtain between really good observers is much more remarkable than their occasional discordance. In the present instance there can be no question as to the existence or the shortness of the period; but it has been variously given between 112 years (Jacob) and 74 years (Encke). Smyth and Sir J. Herschel prefer about 80 years. Secchi's later measures, 1860·638, gave 6″·022 and 105°·46. The distance is, undoubtedly, again on the decrease. This pair acquires an extraordinary interest from the recent determination of its parallax—0″·169—by Krüger, Argelander's assistant at Bonn. This, of course, though he considers its limits of error to be only 0″·0103 *plus* or *minus*, is open to revision by other instruments; but adopting it as a basis till disproved, it will give us a distance which light could only traverse in 19¼ years,

and a mass of the larger star equal to $2\frac{3}{4}$ times that of our Sun. Well may we gaze upon such an object with astonishment and reverence !*

43. λ *Ophiuchi*. 1″· 351° ·2 (1834·48). 1″·2. 15°·5 (1853·25). 4 and 6. Yellowish-white and smalt-blue. This fine pair is unquestionably in orbital motion with a period, according to Hind, of about 96 years. Secchi's three measures give, at a mean, for 1857·5, 1″·35 and 20°·1. I divided it with an aperture of $3\frac{7}{10}$ inches and a power of 250 in 1856. It may be found by a line from *a Herculis* to the *n p* star of the two called *Yed* (see No. 15) at about two-thirds of the distance, and should be looked for soon, before it gets near the horizon.

We proceed to a grand object—

44. θ^1 and θ^2 *Serpentis*. 21″·6. 103°·9. $4\frac{1}{2}$ and 5. Pale yellow and golden-yellow. This is a superb pair, and one of the finest in its class, and it lies in a glorious field. The magnitude of θ^1 has been very differently rated, and it should be watched, as pretty certainly variable; for which its vicinity to θ^2 affords an unusually favourable opportunity. A line from 70 *Ophiuchi* to *Al Tair* will pass somewhat above this object, nearly in mid-distance. It lies in the vacant space between the two streams of the Galaxy, and not on the western edge of the eastern stream, where globes and maps usually, if not always, place it. This traditional misrepresentation of a very obvious and well-marked feature must have had its origin and continuance in that idle spirit of unhesitating copying to save trouble, which has been the cause of so much evil in many branches of research, but is especially inexcusable in such an instance as this. In many questions of history and archæology, reference to original documents may be very inconvenient, perhaps impracticable; but here nothing could have been more easy than that verification which no one seems to have thought it worth while to make.

A still more brilliant double star is—

45. a^2 and a^1 *Capricorni*. 6′ 13″·4. 291°·4. 3 and 4. Pale yellow and yellow; each with a faint attendant, that of a^2 (the larger star) being at some distance. There is a 5th most minute star 5″ from a^2, so delicate as to have been caught only once by Smyth in "little evanescent flashes," with an aperture of 5·9 inches. Sir J. Herschel has thought that it may pos-

* There seems to be some peculiarity, hitherto quite unexplained, about the light of this star. The rings which, under a high magnifying power, surround the spurious discs of stars, are commonly accounted for as the result of the "interference of light," on which supposition they would be an invariable phenomenon. Yet Sir J. Herschel says "the rings of this star seem to have something peculiar. They are thin, and extend farther than in general?" and in another place, "difficult, owing to the rings and appendages. N.B.—I always find this star difficult from the above cause."

sibly shine by reflected light; but the discovery of planetary systems in the starry heavens, though perhaps just waiting, as it were, at the door, has not yet broken upon us. No relative motion has hitherto been perceived in this grand object, which is double even to the naked eye, the finest of the few thus visible in the whole heavens. The components are, in fact, one-fifth of the Moon's diameter asunder, though they appear much closer;—an instance of the little dependance to be placed upon eye-estimates of distance when the objects compared are of dissimilar kinds. This leader of Capricornus is easily found, being the uppermost of two 3 mag. stars not far apart, and in a line sloping downwards a little to the left, coming to the meridian after *Al Tair*, but much lower in the sky, not higher than the February Sun, about 9h. P.M., during the second week in September.

OCCULTATIONS.

The following may be observed during the month:—September 2nd, 4 Sagittarii, 5 mag. immerges at 6h. 33m., emerges at 7h. 48m; 3rd, *o* Sagittarii, 4 mag., is occulted from 8h. 28h. to 9m. 41m.; π Sagittarii, 3 mag., from 11h. 46m. to 12h. 5m.; 5th, 9 Aquarii, 6 mag., from 10h. 9m. to 10h. 27m.; 8th, 16 Piscium, 6 mag., from 9h. 59m. to 11h. 11m.; 30th, 28 Sagittarii, 6 mag., from 6h. 45m. to 7h. 38m.; 30 Sagittarii, 6 mag., from 9h. 18m. to 9h. 38m.; 31 Sagittarii, 6 mag., from 9h. 42m. to 10h. 38m.

THE COMET.

This beautiful and tolerably conspicuous visitant, the second of the current year (whence in astronomical language it will be called Comet II. 1862), was discovered at Florence by MM. Pacinotho and Toussaint, July 22; after which date it gradually increased in visibility during its approach to both the Earth and Sun; its *perihelion* passage occurring on August 23, and its *perigee*, or closest proximity to the Earth, seven days later, its distance from us being then 32½ millions of miles, about one-third that of our distance from the Sun. Its subsequent course declines rapidly southwards through the N. part of Boötes, Corona Borealis, and Serpens, crossing the equator on September 5th, to disappear shortly afterwards beneath the W.S.W. horizon. It will therefore have already diminished before these pages can reach our readers, and they must lose no opportunity of studying its aspect, which at the present time (August 22) presents some interesting features, though nothing comparable to the fuller development of Donati's Comet, or the great one of July 1861; as far, however, as the "sector" adjacent to

the nucleus is concerned, there is much resemblance to the comet of last year. The tail, which arises irregularly from only a part of the breadth of the coma, is short, as yet, in proportion to the brightness of the head. At present, no conclusion can be safely formed as to the period of this comet, whose orbit is said to have a slight resemblance to that of the year 770. Detailed observations, which have hitherto been but few, from the pertinaciously adverse condition of the sky, will be given in a future number.

HYDRAULIC ILLUSIONS.

BY W. B. TEGETMEIER.

THOSE visitors to the metropolis who accept Dr. Johnson's invitation, and take a walk down Fleet Street, may have noticed the small crowd of wondering gazers usually assembled around a shop window a few doors west of Temple Bar. The object of attraction being, not the exterior of the earthenware filters vended by the occupant, but a series of hydraulic contrivances and designs, the most attractive of which is a perpendicular glass tube, some six feet in length, up which is seen passing in endless and regular succession a series of bubbles of air, as unsubstantial and as interminable as the line of shadowy kings that passed before Macbeth.

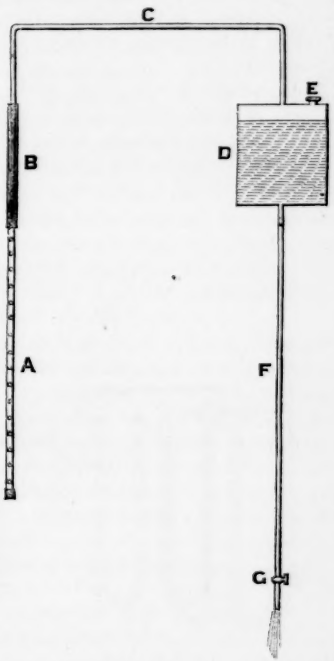
The mechanism by which this exceedingly effective and pretty contrivance is produced is entirely concealed; and as the occupant of the warehouse astutely declines to afford any information on the subject, the matter has remained for several years one of the unsolved enigmas of the town.

That the means adopted to produce the result are not generally known is evident from the fact, that the design has not been imitated, which, from its attractive character, would have been the case had the means by which it is effected been understood.

Scientific knowledge is not, however, the exclusive property of any one individual; and as Mr. Lipscomb has had for a very long period the benefit of this attractive advertisement, we have no hesitation in laying bare the concealed mystery, at the same time giving him every credit for the knowledge displayed and the ingenuity manifested in the contrivance.

The ascent of these bubbles is obviously produced by means of an apparatus known to chemists under the name of an aspirator, from its being employed to draw a current of air or gas through any tubes or vessels along which it may be required to flow.

If our readers will look at the apparatus, in the Strand they may observe that the glass tube A, up which these bubbles ascend in apparently such a mysterious manner, is perfectly free and unattached below; this want of communication with any other portion of the apparatus rendering the action less easily comprehended. If, however, they look to the upper part of the glass tube they will find that it is enclosed in a metal tube B, and that from this a smaller tube C ascends to and passes along the ceiling of the shop. No other portion of apparatus is visible, and it is the extreme simplicity of the arrangement and the apparent want of any adequate cause that renders the whole so incomprehensible and attractive.

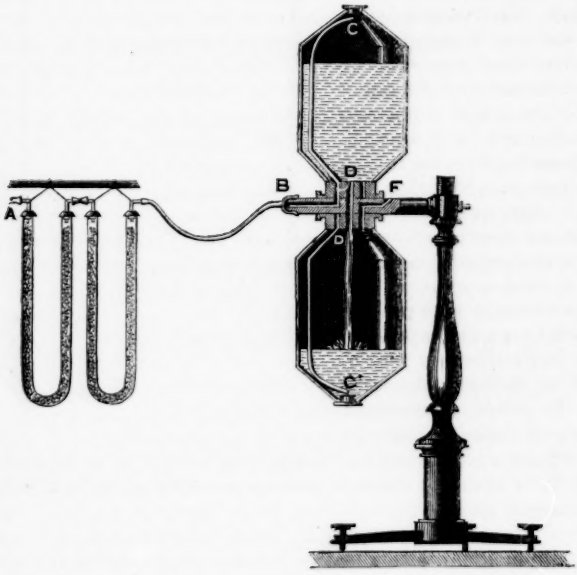


If we wish to understand how the effect is produced, we must imagine that the small tube C, after passing along the ceiling to a convenient locality, is made to descend and enter into a perfectly air-tight cistern D. This is furnished with an aperture E, for the purpose of filling it when required. The aperture is capable of being closed by a screw with a leather washer, that enables the opening to be shut in a perfectly air-tight manner. From the cistern descends a long tube F, having a stopcock at its lower extremity. No particular proportions are requisite except one which is absolutely indispensable, that is, that the length of the column of water in the cistern D and tube F should be greater than that in the glass tube A; and should this be filled with syrup or any liquid heavier than water, the difference must be proportionately greater.

Having described the apparatus, let us now explain its action. We will suppose the glass tube A, which is alone presented to the gaze of the public, to be filled with liquid. Water would answer, but as the object is to cause a slow ascent of the globes of air, a thicker liquid, such as clear syrup, would be pre-

ferable. Whatever may be the liquid employed it is prevented flowing out of the small aperture in the bottom of the tube by a valve opening upwards. This valve is contained in and concealed by the small metal cap placed on the lower end of the glass tube.

The cistern D is filled with water through the aperture E, which is then closed. On opening the small stopcock at the bottom of the tube F, the water will flow out, owing to the greater pressure in the longer tube F than in the shorter tube A. In order to supply the vacancy created in the cistern, the exter-



nal air will enter by the opening at the bottom of the glass tube and ascend in a regular series of bubbles through the liquid it contains. This action will continue as long as any water remains in the cistern, and may be renewed by replenishing it from time to time as may be requisite or desirable.

Such is the simple apparatus that has puzzled the wits of some thousands of spectators during a period of several years, and has tended to give greater notoriety and reputation to the warehouse in which it is placed than many more elaborate contrivances would have done.

The aspirator, as the contrivance is termed on which the action of this deception depends, has long been known to

operative chemists, who not unfreqnently desire to draw a current of air or gas through a tube. For this purpose, however, a far superior instrument has been for some time in use in France; and as it appears to be quite unknown in this country, we have much pleasure in describing its structure and mode of action; its great advantage being that it is capable of being continued in operation during a very great length of time with the same supply of water. It consists of two reservoirs placed one above the other, and which are capable of being turned easily on the horizontal axis B F, which supports them. In the position shown in the figure the air is drawn in or aspired through the flexible tube ending at B, and is conveyed above the level of the water at C, into the upper vessel, replacing that which falls into the lower reservoir by the canal D D. The air in the lower vessel escapes by the tube E F as the water enters.

When all the liquid has fallen out of the upper reservoir it is evident that the action of the instrument ceases; but it is capable of being immediately renewed by simply turning the two reservoirs so as to bring the one filled with water uppermost, when, as they are constructed in a manner precisely identical, the liquid will again flow, and the aspiration of air proceed until the water has again flowed into the lower vessel, which may be then returned to its original position, and so on, the action continued indefinitely.

The engraving is taken from Jamin's *Cours de Physique de l'Ecole Polytechnique* a work which, we may remark, in passing, is far superior to any class text-book of physics in our own language, and which ought to have been translated long since. In this cut the aspirator is represented as drawing air through two U tubes filled with pumice saturated with sulphuric acid, the object being to determine the amount of hydrometric moisture it contains.

GLEANINGS FROM THE INTERNATIONAL EXHIBITION.

MICROSCOPIC DIAMOND WRITING.—Within the last few days Mr. Webb has placed his apparatus for executing microscopic writing on glass amongst the philosophical instruments in the northern gallery. The instrument may be described as a long perpendicular rod or lever carrying at its lower end a pencil, which is traced over the original writing that is to be reproduced in miniature. The short arm of this lever is concealed in a box above, and acts upon a second lever, the arrangement being repeated until the motion, which originates with the hand below, is reproduced in the required degree of minuteness.

The extremity of the lever moving through this small space,

carries a diamond point, which is pressed against a thin plate of glass, producing by its action a micrograph of the design over which the long arm of the lever is traced below. The apparatus is a modification on that originally designed by Mr. Peters, and produces effects which have not hitherto been obtained. As examples of its power of executing fine writing, it may be stated that the entire of the Lord's Prayer may be easily written in a space of the one 2500th of an inch, and the entire of the first chapter of St. John, containing 51 verses and 4137 letters have been written in less than the one thousandth of an inch, a degree of minuteness which would enable the whole Bible to be written in the space of two square inches. Notwithstanding their excessive minuteness, the letters are easily legible under a high magnifying power, each line being perfectly distinct. The instrument is equally applicable to the engraving of linear designs. Amongst those that have been engraved, and which are exhibited by Mr. Webb, may be mentioned a long geometrical spiral in the one 2000th of an inch, and a comic illustration of a joke of Captain Marryat's which can be covered by the point of a pin.

The true value of the instrument, however, is shown in its application to the purposes of microscopic science; it is capable of producing Nobert's microscopic tests in bands of lines numbering 100,000 to the inch, and micrometers with divisions rising to the one 4000th of an inch, which, when crossed, produce perfectly distinct and sharp angled squares, each of one-sixteenth millionth of an inch in size ($4000 \times 4000 = 16{,}000{,}000$).

As our notice may be the means of sending many to look at these astonishing results, it may save some trouble by stating, that having been introduced during the last few days, the micrograph will not be found in the catalogue, but its locality is readily ascertained as it is placed against one of the pillars of the northern gallery, on the railing overlooking the court below.

Analysis of New Minerals in the Exhibition: Dysodile.—In the Museum of Practical Geology, in Jermyn Street, will be found a large mineral mass labelled somewhat in the following style:—"Combustible matter from the banks of the river Mersey, north side of Tasmania." Specimens of the same substance are also to be seen in the Tasmanian Court of the International Exhibition, and it seems certain that this "combustible matter" is nearly identical with a rare mineral described as dysodile in Chapman's *Mineralogy*. It presents the appearance of a brownish-grey slate rather than that of any kind of fuel; yet it burns freely, though with a very offensive smell, when held in a flame. It has been employed in the locality of its occurrence instead of coal.

Examined with a magnifying lens of low power, the combustible constituent of dysodile is seen to be disseminated pretty uniformly through the mineral in the form of small flattened drops of a pale brownish-yellow colour, and marked with a few ridges radiating from the centre of each disc. When a piece of dysodile is crushed in a mortar, and the fragments warmed with strong hydrochloric acid, these discs float in the liquid and may be easily separated. They are nearly, if not quite insoluble in ether, alcohol and benzol, thus

differing from solid paraffine; they require a high temperature to melt them; and have been found on analysis to contain, in addition to carbon and hydrogen, a small percentage of oxygen.

Dysodile, in its native state, can scarcely be termed a "combustible matter." By far the largest part of it is inorganic and incombustible, as the following analysis shows:—

Combustible matter	36·51
Water, etc.	2·30
Mineral matter or ash containing silica alumina, iron, soda, etc. . . .	61·19
	100·00

Albertite.—Under this name a beautiful, most lustrous, and intensely black substance is exhibited in the New Brunswick Court. Albertite presents the general appearance of a very excellent cannel-coal, and breaks with an extremely brilliant conchoidal vitreous fracture. Its jet black powder, when heated in an open vessel, melts, and then gives off great quantities of combustible vapours, leaving a light and bulky coke. But there is one point to be observed here of great interest—this coke is pure carbon, there being, in fact, practically speaking, *no ash* in Albertite, as the following result proves:—

1·55 grammes of Albertite left ·001 or 1 milligramme of ash.

This is equal to no more than ·0645 per cent., while we believe that no cannel-coal or anthracite hitherto analysed contains so little as 1·0 per cent. Among its volatile constituents Albertite contains mere traces of sulphur and nitrogen.

Together with the Albertite itself, specimens of oil produced by its destructive distillation in close vessels are also exhibited. They are admirably adapted for burning in paraffine lamps, affording a good light, having little or no disagreeable odour, and not forming, under any circumstances, an explosive vapour. In fact, a sample of the oil, when submitted to fractional distillation, did not commence to boil until the thermometer had risen to 338° Fahr., or 126° above the boiling point of water; while only half the oil had came over at 482° Fahr., one-seventh remaining in the retort when it had been raised to the boiling point of mercury.

The discovery of large sources of native mineral oil has caused the manufacture of Albertite oil to be discontinued. This is a circumstance to be regretted, as we are convinced that it far surpasses in its illuminating power, freedom from smell, and perfect safety in use, any hydrocarbon oil that has come under our notice.

We may mention, that the analysis of these two singular minerals has been made by Mr. A. Church, who is continuing the investigation of their composition and general properties.

Frog in Block of Coal.—In the open court adjoining the eastern annex, is a tall block of coal from Russell's new Black Vein, in which has been excavated a square opening, wherein is placed a glass jar containing a living frog. The statement is not definitely

made, but it is allowed to be inferred that the frog was discovered in the coal when the latter was excavated.

The accounts of living frogs being found enclosed in trees or blocks of recent formation are never found to bear the test of scientific scrutiny; the occurrence of a living animal of the most recent creation in a formation of such a degree of antiquity as the coal measures, is perfectly impossible. The animal should be turned over to some travelling show-van, containing mermaids and sea-serpents, its being shown in the International Exhibition is calculated to render the management of the scientific department the object of ridicule to all intelligent foreigners—in the name of the scientific men of this country we strongly protest against the continued exhibition of this ridiculous absurdity.

NOTES AND MEMORANDA.

Temperature of Snails.—M. J. B. Schnetzler has been experimenting on the temperature of the terrestrial mollusks, and has arrived at some interesting results, which are recorded in the *Bulletin Scientifique*. He began with the *Helix pomatia*, the large pale fawn-coloured snail, not uncommon in our lanes and woods, and which is considered fine eating by epicures abroad. In April, 1861, when the air temperature was 12°.1 Cent., a snail of this kind was a little warmer, 12°.5. In June, when the air was 23°.7, the thermometer, when covered with the snail's foot rose to 24°.7. A few days later, when the thermometer stood at 18°.7, it rose on being introduced into the snail shell, and brought as near the respiratory cavity as possible, to 20°. Irritating the muscles of the animal gave a further rise of .75°. In July a lively Helix pomatia, by mere contact of its foot, raised the thermometer 2½ centigrade degrees.* Half an hour later, the air rose one degree, but the snail remained the same. In September, after some snails had closed their shells for a month, a shower of rain came, and although they were kept in a room, they woke up, but their temperature did not exceed that of the surrounding air. In January he placed two snails in the open air, having removed their operculum. During the night the temperature fell to —2° Cent., but they were not injured; on a subsequent night, at —8°, they froze and died. Slugs have a lower temperature than snails. M. Schnetzler proposes to call these creatures "animals of variable temperature," in contradistinction to mammals and birds whose temperature is usually more equal, if we except the changes which hybernating mammalia undergo. Mollusks may become colder than the air, by evaporation from their skin, and Dutrochet found that frogs became noticeably warmer in air saturated with aqueous vapour, and, consequently, suspending their evaporation.

Cleaning Engravings.—Dr. Hayes, of Massachussetts, in the *Scientific American*, recommends old dirty engravings first to have any pencil marks removed with india-rubber or bread crumbs, then to have every spot saturated with solution of oxalic acid in the proportion of one ounce to a quarter of a pint of warm water. A few hours afterwards the engravings may be placed in a tub or foot-bath, being allowed to rest upon a piece of open cotton stuff, such as ladies used to employ for stiff petticoats before the return of hoops. This material, of suitable dimensions, should have two rods or sticks sewn to opposite edges. These sticks will hang over the sides of the vessel, and permit the prints to be withdrawn or moved without any risk of injury, and they should remain in soak with warm or cold water for twelve or twenty-four hours. When the prints no longer discolour the water on being agitated, the fluid should be withdrawn, and enough clean water added to cover them. Half a pound of chloride of lime should be made into a paste with

* A degree of Fahrenheit is equal to five-ninths of a degree of the Centigrade scale.

cold water, and stirred up with two quarts of water, and allowed to settle for six hours. Part of the clear solution should be added to the bath till the smell of chlorine is perceived, and the prints should be moved to facilitate the action. In very bad cases, one ounce of muriatic acid mixed with a pint of water may be added, and when the bleaching is effected, the prints should be well washed with fresh water and slowly dried.

M. Flourens on Wounds of the Brain.—The *Comptes Rendus* contains an account of experiments and observations by this distinguished surgeon, showing that wounds of the brain are easily cured. He cites several instances of human beings who have recovered from injuries involving loss of a portion of their brains, and adverts to his own proceedings in introducing leaden balls into the brains of rabbits and dogs. He made a hole in the skull with a trepan, cut through the *dura mater*, and made a slight incision into the brain itself, in which he placed the ball, which gradually sank into the cerebral substance, making a kind of fistula that cicatrized. If the ball was not too big, the whole thickness of the cerebrum or cerebellum might be traversed without being accompanied or followed by any bad symptom or disturbance of functions. He states that, in 1822, he removed one lobe from the brain of various animals, who recovered perfectly, and only lost the sight of the opposite side; and he adds, "but the most remarkable thing was when I removed the whole cerebrum, or both lobes. The animal deprived of his brain survived more than a year, but he had lost all his senses and intelligence, and was reduced to an automaton." In another instance he took away all the cerebellum, and this creature lived a year. It never regained regularity of movements. It was reduced to the condition of a drunken man.

Marriages of Consanguinity.—M. A. Sanson disputes the proposition that these connexions tend to deteriorate offspring, and he adduces many facts relative to breeding horses and other animals in England in support of his view. This paper has been referred to the commission appointed by the French Academy to "consider the effects of consanguineous marriages."

Refraction of Iodine Vapour.—M. F. P. Leroux states that when he employed a prism filled with the vapour of iodine, and "successively illuminated the slit of his collimator by the red and the violet-blue resulting from the dispersion of a pencil of solar rays by a flint-glass prism, he saw the red and the blue images in different places . . . which shows that the refrangibility of the red ray is greater than that of the blue ray in vapour of iodine."

Experiments in Solubility.—M. Girardin has ascertained that when a substance has several solvents, its solubility in a mixture of them is less than the mean of its solubility in each; thus if two saturated solutions in different liquids are mixed together a precipitation is the result.

The New Asteroid.—The 73rd planetoid, which Mr. Tuttle discovered in April, has been named *Clytie* by the American astronomers, after the daughter of Oceanis and Tethys.

Comet 1, 1862.—M. Radau states, in *Cosmos*, that this comet has so little light that it is not easily seen, and could not be detected on 15th July, in Vienna, when the moon was shining. He says: "The parabola which this comet describes does not resemble any cometary obrit we are acquainted with. It appeared suddenly, being at first visible to the naked eye, and moved rapidly towards the North Pole—circumstances which recal the behaviour of the great comet of last year." He then proceeds to show the great difference between the two, that of last year making its *sudden* appearance in the northern hemisphere only. Its orbit had, moreover, a very great inclination, while that of the present comet is very small. From the middle of June to the beginning of August, this comet moved in a direction opposite to the earth's motion, passing above us at the short distance of 4,000,000 of leagues on the 4th of July. It has traversed the plane of the ecliptic very near our orbit, but keeping before us. Taking for the basis of his calculations the elements computed by M. Seeling, M. Radau finds that it intersected the plane of our orbit on the 3rd of June, at 8h. 26m. mean Paris time; its distance being then 700,000 leagues, and less than 300,000 on the 5th of that month.

XUM

On the Rigidity of the Earth.—Professor Wm. Thompson shows that unless the earth were composed of very rigid materials, it would yield under the tide-generating forces exerted by the sun and moon, to such an extent as would sensibly diminish the actual phenomena of tides and of precession and mutation. The upper crust of the earth is possibly, on the whole, as rigid as glass, more probably less than more; but as a whole the earth must be far more rigid than glass, and probably more so than steel. Hence the interior must on the whole be more rigid, probably many times more rigid, than the upper crust. This calculation confirms the views of Mr. Hopkins, and is quite inconsistent with the hypothesis that the earth is a mass of melted matter enclosed in a thin solid shell. Mr. Hopkins has shown that this crust cannot be less than 800 miles thick. Professor Thompson considers that no thickness less than 2000 or 2500 miles would enable it to resist the tide-generating force of the sun and moon so as to leave the phenomena as they are actually found.—*Proc. Royal Soc.* No. 50.

Distribution of Nerves.—In a paper communicated to the Royal Society Mr. Lionel Beale states: "The nerves distributed to the voluntary muscles of the frog do not terminate in free ends, but there is reason for believing that complete nervous circuits exist. In all cases, the fibres resulting from the division of the ordinary nerve fibres are so fine that many cannot be seen with a less magnifying power than 1000 diameters, and there is evidence of the existence of fibres which could only be demonstrated by employing a much higher magnifying power. It is by these very fine fibres alone, and their nuclei, that the tissues are influenced. The ordinary nerve fibres are only the cords which connect this extensive peripheral system." The author finds the same arrangement in the nerves of man and the higher mammals, and also in the invertebrata. He employs a highly refractive fluid, such as syrup or glycerine, in these investigations.—*Proc. Royal Soc.* No. 50.

Mechanism of the Human Voice.—By means of the laryngoscope, Mr. John Bishop has succeeded in watching the movements of the larynx during the utterance of vocal sounds. When the lower tones are made, the vocal cords vibrate through their whole length. As the pitch rises, the vibrating length diminishes, and the cords are pressed more closely together. In falsetto notes, it is only the extreme end of the cord that vibrates. Moreover, the vocal chords form a kind of valve, which is situated in a tube, and acts like a reed. Thus the organs of the voice perform the double office of reed and string.—*Proc. Royal Soc.* No. 50.

Mr. Lassell and the Moon.—At Malta, where Mr. Lassell has erected his magnificent 4-feet reflector, he observes the details of the moon with a sharpness and distinctness which he had never seen before. He states that, if a carpet the size of Lincoln's Inn Fields were laid upon its surface, he could tell whether it was round or square. He adds, in a letter to the President of the Royal Society, "I see nothing more than a repetition of the same volcanic texture—the same cold, crude, silent, and desolate character which smaller telescopes usually exhibit."

The Formation of Halos.—Sir John Herschel has devised an elegant mode of illustrating the action of minute refracting spheres. He mounts the spores of the common puff-ball in a film of oil between two pieces of glass. When these are held close to the eye, and a candle viewed through them, beautiful concentric halos appear.

Optical Experiment.—Mr. Slack calls attention to concentric circles of light, exquisitely marked by fine black intersecting lines, which may be seen by taking a stout glass tube, about one-eighth of an inch in diameter and six or eight inches long, holding it horizontally opposite the flame of a candle, and looking at the light through it. A piece of paper rolled round the tube shuts out all unnecessary illumination, and makes the phenomena more clear.